

MACMILLAN'S NATURE CLASS PICTURES

REFERENCE BOOK

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PREFACE

CLASS PICTURES AND REFERENCE BOOK

NATURE Study implicates the observation of living things. In the class-room, however, it is not possible to provide all the numerous and varied plants and animals needed for the children, and the teacher depends upon pictures to supplement the natural objects available.

The sixty-two Nature Class Pictures, to which this Reference Book is the accompaniment, will be found of immense service in guiding the children in their study. The Pictures are printed in full colour and have been drawn by well-known nature artists—D. Fitchew, F. W. Frohawk, Roland Green, Raymond Sheppard, O. Tassart and E. Tresilian.

A large proportion of the illustrations has been drawn the natural size, many have been enlarged, and some, especially those of the animals and trees, are necessarily reduced. The Pictures cover a wide field. There are one hundred and sixty-four drawings of wild flowers, eighty-nine of British birds, and sixty-seven of insects, in addition to numerous drawings of British wild animals, trees, seashore animals and fish.

This Reference Book contains text descriptive of every creature and plant depicted on the plates. The language of the text is intentionally simple, so that the teacher may the more readily impart the information to the children. The list of Pictures is given on page v and a complete Index is included at the end of the book.

This handy volume will be found invaluable to the busy teacher since it contains in brief the essentials of the many reference books that would be needed for such a large variety of living things.

CHILDREN'S BOOKS

The use of children's books as a means of self-education is now an established practice in most schools. The following two sets of books based on the Class Pictures have been prepared :

1. THE CHILDREN'S NATURE BOOKS.—Four books, each illustrated by sixteen coloured plates reproduced from the Class Pictures and additional drawings in black-and-white :

My Book of Animals and Trees.

My Book of Birds.

My Book of Wild Flowers.

My Book of Insects, Seashore Animals and Fish.

II. ADVENTURES INTO NATURE.—A set of books covering a full four years' course of Nature Study, arranged in parallel books for the "A" and "B" streams of a class, making eight books in all. Each book contains sixteen plates in full colour, reproduced wholly or in part from the Class Pictures, and additional drawings in black-and-white. Chapters dealing with birds, beasts, insects, fish, wild flowers and trees are contained in each book.

Teachers will find in these Pictures and Books a sure foundation for the further study at a later stage envisaged by the Norwood Report.

BIRDS

Introduction.—Birds, through their power of flight, have attained control of a much wider field than most other vertebrate animals. This power of flight is the clue to the special characteristics, both in habits and structure, which distinguish birds from other vertebrate animals. It has made accessible great varieties of food, and enabled the birds to search a wide area rapidly in quest of it. It has enabled them to choose safe, hidden nesting-places, not easily reached by their enemies. It has led to the habit of migration, so that birds can leave their native locality when shortage of food and hard climatic conditions set in, spend the winter in a milder climate where the worms and insects which are their chief food supply are not driven into hiding or killed by cold, and return, probably to their racial home, for the breeding-season.

Migration is not peculiar to birds, but it is a much more widely spread and systematic habit among them than among any other animals. Besides the migrants which seek a new country in the winter, there are others whose migration is limited to a narrower range. They move inland from the sea-coast (gulls, many waterfowl), from northern to southern counties, or from woods, coppices and hedgerows to the open fields, as, for instance, do the chaffinches. It is characteristic of many of the smaller birds to flock together in one sex during the winter, males in one flock and females in another, and in some cases the flocks contain birds of different kinds (house sparrows and chaffinches, or starlings, rooks and jackdaws). They particularly search the ploughed lands for food.

In the spring, urged by the sex instinct, the flocks separate, return to their breeding-haunts, and each male seeks out a territory and stakes a claim, which he often defends against all-comers. Here he and his mate will be able to obtain food and build a nest. Even from foreign shores it is generally noticed that the males arrive first. Authoritative observers of bird life are agreed that the meaning of a bird's song is, first of all, a challenge to other birds to dispute its territory, and, later, an announcement to the females in the vicinity that there is a settled home and maintenance assured to the selected mate. It probably has other emotional significance as well, and is the expression of the bird's exuberant well-being and desire for a mate.

The variety of sites and materials chosen for nests is very great. Usually, birds make a selection from material near at hand, though sometimes they bring back from a distance straw, wool, twigs or feathers. The

weaving and moulding of the nest is accomplished by the beak and feet, according to an ancestral pattern ingrained in the bird's heredity. To some extent, it is thought that imitation comes into play, as it has been found that there is a tendency for young males to mate with older females who have already had nest-building experience. It has sometimes been noticed that the hen-bird decides the actual position of the nest. I have seen a pair of house-martins dispute the exact spot under the eaves, and one settle the matter by firmly dabbing the first spot of mud on the wall. The other accepted the position and together they laid the foundations.

The nests of birds which build in trees and hedges usually consist of an outer shell of fine interwoven twigs. Such material is sometimes reinforced by mud, as in the case of the thrush, perhaps packed in the spaces with bits of moss, lichens and leaves which may help to disguise it. The nest is then lined with softer materials, such as fine hay, hair, feathers, wool and thistledown, which serve as a bed for the eggs to lie on and help to retain the heat of both eggs and nestlings.

The young birds need constant feeding. A pair of blue tits is recorded to have worked from 2.30 a.m. to 8.30 p.m. and averaged twenty-six visits an hour. Swallows are said to feed their young once in three minutes. (Morris, *British Birds*.) It has been suggested that one advantage of a northern breeding-place is the longer working day it allows for feeding the young. Soft, easily-digested, concentrated food is usually provided at first, either caterpillars, fat grubs and worms, or partially digested grain. Pigeons have a special curd-like secretion known as "pigeon's milk."

Although birds are equipped with highly specialised instincts beautifully adapted to their needs, there seems to be some room in their lives for education, or learning by experience. This is one of the advantages of their sheltered home life. Those whose nests are not on the ground are hatched at a sufficiently immature stage to be able to profit by intensive individual methods of education. Young birds are both encouraged and taught by their parents. In flight they are shown what to do, a little at a time, urged to try their wings, and sometimes even pushed off a safe ledge into space. They seem to be guided in their choice of food. A hen with chickens can be seen to encourage them to peck at the food she has found for them.

Structure of birds.—The structure of a bird's body has been profoundly modified in connection with the habit of flight. There seems to be no doubt that in the geological period known as the *Mesozoic*, birds originated from some small and insignificant members of the great group of Reptiles, which then dominated the earth. Professor Thomson, in his

BIRDS

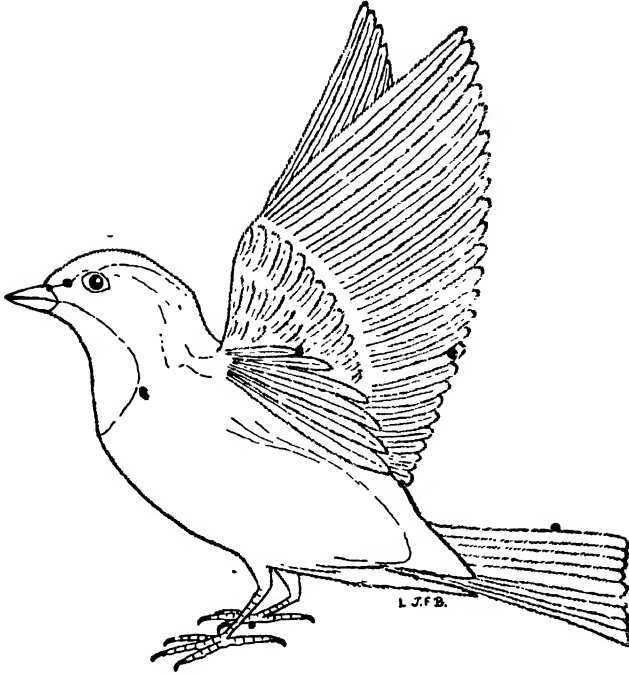


FIG. 1. General structure of a bird.

Biology of Birds, suggests that these were lean, wiry, lizard-like creatures, very active and alert in habit, possibly already able to maintain a high and steady blood temperature and therefore to retain the heat of the body. He thinks that they may already have begun to select concentrated, nutritious food, and to digest it very completely. Possibly they were already able to obtain and utilise a good supply of oxygen, in which case the energy obtained from their food and stored in the muscles would readily be available for their activities. Such creatures would be ready for new adventures. They may have leapt among the branches of trees, and begun to use their forelegs to help them to balance, developing these into wings later.

There is no evidence of the way in which feathers first made their appearance. They are skin outgrowths, supposed to be modified, branching scales, but no intermediate stages exist to throw light on their origin. They are the warmest and lightest covering known. Since the feathers become frayed and worn, it is advantageous that they are renewed yearly. Moulting generally occurs in the autumn, when all the flight feathers are dropped, usually in pairs, and in some cases the bird may

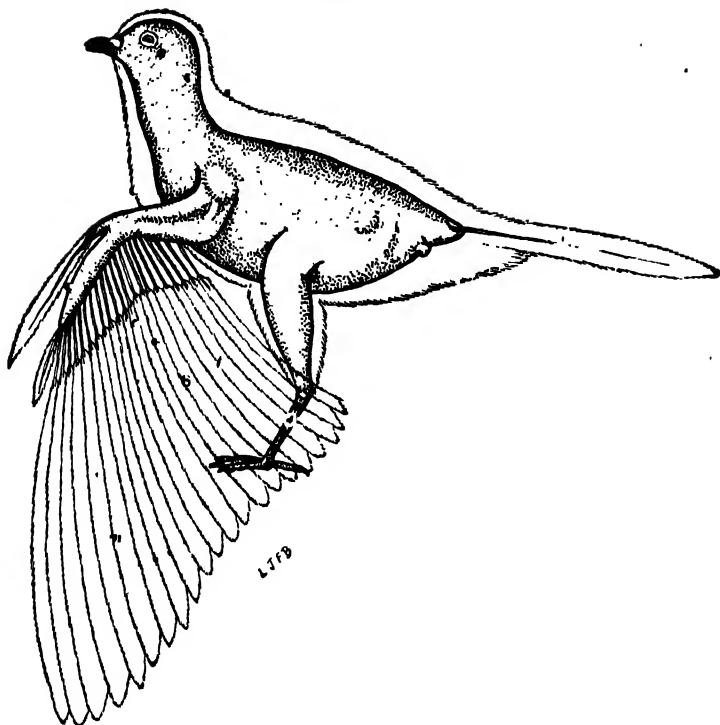


FIG. 2. General structure of a bird, most of the feathers having been removed.

be somewhat impeded in flight, and may even go into hiding. The covering or contour feathers are also shed. In many birds the tips of the new feathers are neutrally coloured, fawn or grey, and, since these are the parts which show, the bird may have a rather drab appearance during the winter. By the spring the tips have worn away, and the bird appears in its bright, characteristic spring plumage.

Male ducks and geese are an exception to the general rule in carrying out the chief moult early in the summer (June), while the young birds still need care. The male retires, leaving the female to assume the full cares of a family, and stays in seclusion until his distinctive plumage has been shed. This is necessary, because all the flight feathers are shed at once. The mallard or common wild drake emerges almost indistinguishable from the duck, but gradually a second moult of the contour feathers makes room for the brightly coloured winter coat, which lasts till after the breeding-season.

The earliest bird we know appears in the upper Jurassic rocks of the Mesozoic period. There are only two specimens of this Mesozoic bird, the famous *Archæopteryx* (ancient-bird or first-bird) found in certain limestone rocks in Bavaria. The complete skeleton was preserved in each case, slightly distorted but in excellent condition, with an impression of the complete series of flight feathers or quills of the wings



FIG. 3. *Archæopteryx*.

Compare with a modern bird. Note the teeth, the wing bones like those of a quadruped, the toes of the wing and the 18-20 vertebrae of the tail. (After Parker and Haswell.)

BIRDS

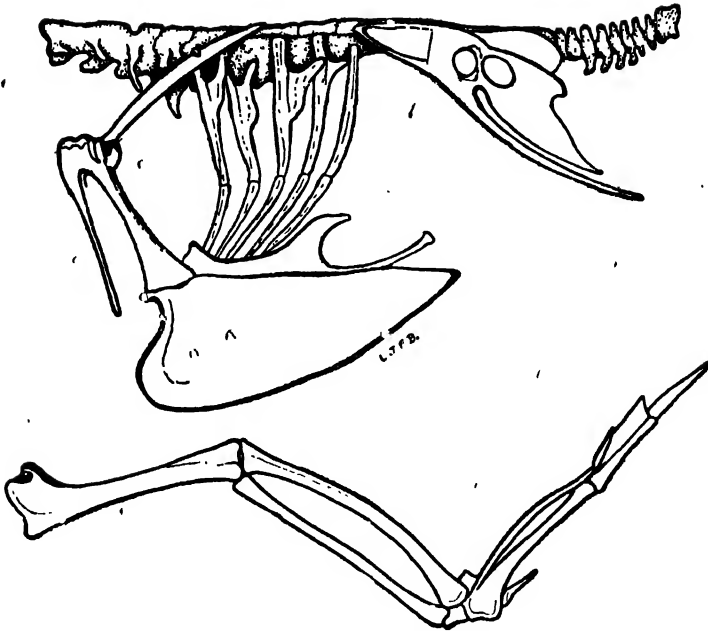


FIG. 4. Above, bones of a bird's body ; below, bones of a wing.
Note how the bones of the body are fused together, and how those of the hand are reduced in number and fused.

and tail. Its skull was drawn out into beak-like facial bones, and had the general character of the head of a modern bird. Its feet and legs were those of a modern bird. The beak, however, was provided with sharp, needle-like reptilian teeth, the wing bones were like the forelegs of an ordinary quadruped, and each fully feathered wing terminated in three toes with sharp claws. Its tail, instead of being a short stump of bone, consisted of a long chain of vertebrae with feathers joined along its length. This creature therefore showed relationships with both reptiles and modern birds and provided a valuable chapter in the tale of their racial origin.

Considered as a flying machine, a bird is a body heavier than air, capable of being propelled through the air by its own engine power, provided by the heart and muscles. Its wings serve both as propellers and planes to increase the resisting surface. It is essential that both the body and the levers working upon it and forcing it forward shall be rigid. Hence the bones of the body have become fused or bound together, while the bones of the hand have been reduced in number and fused together to

form, with the arm bones, a firm rod which makes a strong stroke, pressing downwards and backwards upon the air, and thus raising the body and driving it forwards.

The need to produce a wide surface which will offer great resistance to the air without adding appreciably to the weight, is met by the wing being provided with strong flight feathers, fixed to the bones of the forearm and hand. Muscles enable the feathers to be opened or closed. The wing is forced down by the contraction of the large breast muscle, attached to the front of the wing and to the broad expanse of bone covering the chest and projecting forwards as the strong ridge of the keel. This is the breastbone, very much enlarged. It remains to bring the wing back into position for the next stroke without checking the flight by offering any further resistance to the wind. The wing is drawn upwards by the contraction of a smaller muscle, also attached to the breastbone but passing through a hole where the wing joins the shoulder blade, as over a pulley, to its insertion on the front of the upper wing bone. At the same time the feathers are slightly separated to allow the air to pass through them and thus reduce the resistance. (This separation can be noticed in pigeons as the wings meet over the back when they rise from the ground, or in rooks raising their wings as they pass overhead.) While the wing as a whole accomplishes the downward and return stroke, the tips are said to describe a figure 8.

To increase the supply of oxygen, the lungs are prolonged into air sacs which act as reservoirs whose supply is available as the air is driven out, so that oxygen can be extracted by the blood in the walls of the lungs during both phases of the process of respiration.

The use of the forelimbs for flight has thrown the weight of the body backwards on to the hip girdle and hind legs, which are strengthened and modified to support it.

Classification of birds according to habits.—The natural classification of birds is based on details too technical for anyone but the expert to grasp, yet the nature student requires some system of grouping which will help him to understand the lives of birds and to remember what he has learnt. The plan usually adopted for this purpose is to classify birds according to their habits, especially their habits of feeding and the modifications of the beak and feet which are associated with it. In some cases this scheme includes natural relationships, for instance, in the *Birds of Prey*.

(a) *Perching-birds*.—The soft-billed and hard-billed small birds are often grouped together in this way, because, when not actually in search of food on the ground or on the wing, they rest in the trees and hedges, where

they also spend the night, and find shelter in winter. A special tendon in the foot of all birds which roost tightens automatically on contact with the perch and prevents the bird from falling off in its sleep. (The tendon can be seen in a hen's foot severed from the leg.) This group includes most of the song birds.

(b) *Swimming birds*.—Birds which feed in water, for example, ducks, have broadly webbed feet and a flattened bill provided with grooves which sift the mud and keep back small creatures as food. Ducks are closely related to geese, which, however, do not feed in the water, but on grass. Their beaks are not so flat. Gulls, which also have webbed feet, can both dive from a height and swim for food. This links them up with the *Diving-birds*, such as the cormorant and the great diver, and with the penguins, which have lost all power of flight, using their wings only as flippers to swim through the water. Gulls are mainly sea birds, but frequently they come inland in winter, whereas ducks chiefly frequent inland water, though some spend part of their time on the seashore. The birds which get food by diving, usually have a strong, sharply-pointed beak for holding slippery victims.

(c) *Wading-birds*.—The heron is fairly common in some districts, and the snipe and many other small wading-birds frequent our river estuaries, finding shell-fish and worms in the sand and mud, and small fish, crabs and shrimps in the shallow water between the tides. Their long legs lift them above the water, they grasp their prey with long, sharp beaks, and they reach down to search for it with their long necks. Amongst foreign birds the stork is well known and is regarded with affection in the countries where it nests or winters.

(d) *Birds of Prey*.—The *night birds* are represented by the owls, and the *day birds* by the hawks, kites and eagles. A pair of kestrels is commonly seen hovering systematically over a field. The kestrel is larger than the sparrow-hawk, and in the air its wings appear to reach backwards to the tip of the tail, whereas in the sparrow-hawk they are shorter than the tail. The tawny cinnamon colour of the kestrel is striking at close quarters. It preys chiefly on small mammals, whereas the sparrow-hawk hunts chiefly birds. These birds of prey are all distinguished by the strong, down-curved beak and curved talons, which close automatically in the flesh of the victim as the bird swoops down upon it. The beak is often driven into the skull, killing the prey instantly, and is then used in tearing the flesh.

(e) *Carion birds*.—These form a miscellaneous group of mixed habits and various natural relationships. The vultures are related to the eagles, and may be regarded as degenerate in their habits, but very useful as

scavengers in hot countries where there are primitive ideas of sanitation. The carrion crows do not confine themselves to dead food. They are related to the rooks, jackdaws and starlings, which feed upon worms, insects and small animals generally.

(f) *Scratching-birds*.—These are ground-dwelling birds, feeding chiefly on grain. They have strong, short claws and beak, useful for pecking and scratching the soil. They include the domestic fowl, grouse, partridge, pheasant and most game-birds.

(g) *Running-birds*.—This is a small group, of which the ostrich is the best known. Their distribution is limited to Africa, Australia and South America. They are among the oldest races of existing birds, and have almost lost their wings. In the ostrich the wing is very small and the feathers are the familiar, long, soft plumes, which are useless for flight. Their relations are the emu of Australia and the cassowary of South America. All three are plain-dwellers and swift runners. The little apteryx or kiwi of New Zealand has become extinct within recent times.

The making of apparatus for bird study.—During the winter, many non-migratory birds find it difficult to obtain food and water. Grubs and insects remain hidden underground or in deep cracks and crannies in walls, rotting wood, or bark. Rain may not fall for several weeks; streams and ponds will, in severe weather, become frozen. This shortage of food and water can be turned to our advantage, for in supplying the birds with nourishment we can give ourselves the opportunity of more closely observing their form and habits.

A bird table and a bird bath can usually be arranged even where space is limited. The best place for the bird table is in an open part of the garden, so that the birds can easily see if cats are about. It is a great advantage for school observations if a sanctuary can be made by surrounding the garden with a high wire fence, with a sloping, in-turned or out-turned ledge about a foot wide at the top. The ledge makes it almost impossible for cats to climb over. The enclosure needs to be sufficiently wide for the birds not to feel trapped, or they will not come. Failing this plan, a tray may be secured by staples to a wall, or be hung from a window.

It is usually said that a bird table should be so high that cats cannot spring on to it, and a height of 4 ft. 6 in. is suggested. This, however, is open to some objections. It is doubtful whether cats would be deterred by this height, and birds which feed on the ground often seem reluctant to use so high a table. Such birds are very wary when feeding, and provided there is no cover for an enemy, they would usually see one

approaching. A height of 2 ft. 6 in. is preferable, as being easier for children to see, and many birds seem to prefer something still lower. On the other hand, some of the shyer and smaller birds will come more readily to food hung from the branch of a tree, from a post or a window frame. A convenient device is to screw on to a window ledge half a child's wooden hoop from which strings of shelled peanuts, a half-coconut, or a piece of fat on a string, can be hung. Bunches of berries can also be suspended.

In order to see which food is chosen by different birds, it is a good plan to use very small plant-pot saucers or other small shallow vessels on the bird tray, and fill them with different kinds of seed. Mixed bird seed may be used, also wheat, maize, split peas, hemp, peanuts and sunflower seed, the seeds of wild grasses and plants of the parsley type. Indeed, it is good to experiment with several different kinds. Crumbs can also be put out, but they should be broken quite small. A lump of suet or fat bacon is appreciated.

The bird bath should be a shallow vessel, either on the ground or raised a few inches, with a conveniently thick rim on which the birds can perch easily. It should hold about two inches of water. A large earthenware plant-pot saucer or bulb bowl is quite good for the purpose. It is better if the receptacle slopes gradually to the middle. If there is a small artificial pond in the garden, birds will often use this for drinking.

The bird table, the bath, and all receptacles should be regularly cleaned. The bird table should be scrubbed and repainted if necessary; the water should be drained from the bath, which should be scrubbed before it is refilled with fresh water.

PLATE I. HARD-BILLED BIRDS

With the exception of the hedge sparrow, which is soft-billed and included for comparison, the birds on this Plate are of the Finch Family (*Fringillidæ*), all well-known and attractive genera. They belong to the group of *perching-birds* and have certain characteristics which make it possible to tell finches fairly easily. They are to a great extent seed-eaters and in this respect are both friends and foes of the farmer and gardener, destroying the seeds of many harmful weeds, but also in some cases doing harm in the cornfield and garden. The bills are stout, short and powerful, admirably adapted to crushing seeds. Finches are in general active little birds; their flight is undulating and most members are sociable, flocking in parties during the winter in the search for food.

The House Sparrow.—Length, 6 to 6½ in. Wing, 3 in. The general colour of the back and wings is brown. The head is slate-grey; the neck, chestnut-brown; the breast, grey; the throat and chin, black. A distinguishing feature in flight is the oblique, pale fawn bar, black-edged, across the wing. The beak is short, broad and strong. The female is smaller and paler in colour than the male; she lacks the black patch on the throat and chin, and has streaks on the head.

Habits.—This perky little bird may be seen in almost every street and garden in these islands announcing its presence by its incessant chirping. It is wary and independent in character, cocksure and pugnacious.

The flight is undulating like that of most finches, except when fluttering short distances.

Sparrows are omnivorous birds, though seeds and grain are largely eaten. They do considerable harm in gardens, attacking fruit buds, pulling up new-sown peas, and tearing to pieces brightly coloured flowers; they flock in thousands to feed on ripening grain in the cornfields. With their quarrelsome possessiveness, sparrows drive away helpful insect-eating birds such as swallows and house-martins; but they do good by feeding their young on harmful larvæ and eating the seeds of certain weeds.

Breeding.—There are three and sometimes four broods. The untidy, straw nests are variously situated—under eaves, in chimneys and spouts, in holes in walls, or in the stolen nests of other birds.

The Tree Sparrow.—Length, 6 in. Wing, 2½ in. The head is of a rich chestnut colour with white cheeks and a black throat. There is a double white band on the wings which are brown, mottled with darker brown. The underparts are greyish. The tree sparrow may be distinguished from the house sparrow by its chestnut head and the black patch on its white cheeks, as well as by the white wing-bars.

Habits.—This bird is a fairly common resident and may be found in most parts of Britain. In the north-east, the tree sparrow is migratory, arriving in autumn and returning overseas in spring.

The tree sparrow is a timid little bird, with quick dainty movements which help to distinguish it from the larger house sparrow. In winter, tree sparrows may flock with other sparrows and finches, visiting rubbish



FIG. 5. Beak and foot of house sparrow.

reddish-brown, and a little dusky-black on the head. The back and wings are deep reddish-brown, with lighter and darker markings. The female is smaller than the male and the colouring is less bright. She has a dark "moustache" and more numerous dark striations than her mate.

Habits.—This bird is a common resident in the British Isles, migrating in flocks from one district to another during the winter. It is very characteristic of hedges and open, cultivated country. During winter, many yellow hammers may be seen in farmyards associating with other birds to search for fallen grain. They are largely grain-feeders; in summer a good many insects are eaten and fed to the young.

The song is the well-known whistling melody, commonly represented by the words—"A little bit of bread and no cheese—se!" This song begins as early in the year as February, and is usually sung from the top of a hedge. The flight is undulating, like that of most finches.

Yellow hammers are warlike birds and frequent skirmishes occur, especially during the mating-season.

Breeding.—There are two or more broods, the first eggs being laid about the end of April. The nesting-site is usually low down in a hedge or in a clump of grass at the foot. Moss, roots, small twigs and hair are used to make a neat, compact nest.

Three to five eggs are laid; they are pale purplish-white, with thin zigzag streaks and blotches of dark reddish-brown, looking like scratchy writing, and giving the bird the local name of "scribbling lark."

PLATE 2. SOFT-BILLED BIRDS

With the exception of the starling, the birds on this Plate belong to the Thrush Family (*Turdidæ*). They are all *perching-birds* and have slender, pointed, "soft" bills, suited to their insect diet. The sharp beak is excellent for spearing worms, or for picking up small insects, pincer-like. Members of this family are in general sweet-voiced, the song-thrush being one of the best known and most popular of European song birds. The starling belongs to the Starling Family (*Sturnidæ*). It is related to the carrion crow, which may be classed as a *carrion bird*, though its food consists of live as well as dead food. Starlings feed upon worms, insects and small invertebrate animals generally. They are also fond of household waste food.

The Starling.—Length, 8½ in. Wing, 5 in. The summer and winter plumages of this bird differ considerably. In summer, a clean starling is beautifully clad in a glossy, metallic purple, green and blue. The bill is bright yellow and the legs light brown. In winter, the sheen is hidden

by the pale tips to the new feathers, which give the bird a spotty appearance; these tips have worn away by the spring, when the starling once more appears in its glossy brilliance. The female is similar to the male, but her summer dress is more sober.

Habits.—Many starlings are permanent residents; others are visitors, huge flocks arriving to winter in this country.

This comical bird is found all over the country in such numbers that everyone must be acquainted with it. Starlings are garrulous; they chatter, chuckle, call and whistle continuously while searching for food, or when perched on some high outpost preening their feathers. They are imitative and they copy the notes of various other birds. As soon as the young are out of the nest, starlings become gregarious, flocking in thousands to feed in the fields. The complicated, aerial evolutions of a flock of starlings are interesting to watch. The flock spreads out, then masses together; now it wheels slowly, then sharply turns, the birds plunging down simultaneously into the trees. There is endless variety in the manœuvres. In flight, the wings beat quickly; the bird can also sail with motionless wings. Insects are caught on the wing.

The food is varied. Originally, the starling was a helpful bird, devouring great numbers of insect pests, but lately the rapid increase in the numbers of the birds has resulted in a change of feeding habit. Now, the starling not only feeds on insects, but plunders grain and fruit; the habit of feeding in great flocks may have dire results on a crop of sprouting grain. Starlings perform a useful service by pecking from the backs of sheep the keds and ticks which infest them.

Breeding.—There are two broods. The large, untidy straw nest is usually placed in a hole in a tree, cliff, chimney, haystack or other high situation. Five to seven eggs, pale blue in colour, are laid in April.

The Song-Thrush.—Length, $8\frac{1}{2}$ in. Wing, $4\frac{1}{2}$ in. The general colouring of the upper parts is brown. The pale fawn or white breast is spotted and streaked with dark brown. The bill is dark brown and slender. The female resembles the male.

Habits.—This is one of our best-known birds, and it is a favourite songster. Many song-thrushes are winter residents, but many migrate, either farther south for the winter or to other breeding-places.

The beautiful song may be heard almost all the year round; even in



FIG. 6. Beak and foot of starling.

January or February the song-thrush sings joyously during a warm, bright spell. A characteristic habit of the bird is to choose some favourite branch of a tree, often the highest twig, where it will perch and sing for hours together, returning to the same spot day after day.

The food is chiefly worms, slugs and snails; the soft bodies of snails it extracts by cracking the shells on a stone. A favourite "anvil" may often be found surrounded by the broken fragments of snail shells.

On the ground, the song-thrush both runs and hops. The flight is quick and direct with rapidly moving wings.

Breeding.—There are two or three broods in the summer. The nesting-places are various—a hole in a wall, the fork of a tree, a hedge, a bank, or a shelf of ground. The strong, deep cup is made of grass, leaves, straw, wool, etc., lined always with mud. Thrushes usually lose no time in nest-building, and the four or five bright blue eggs, spotted with black, are soon laid. The young are similar to their parents, but their upper parts are also spotted with buff.

The Mistle-Thrush or Missel-Thrush.—Length, 11 in. Wing, 6 in. This bird is larger than the song-thrush, and greyer in colouring. The breast is lighter and heavily spotted with dark brown, the spots being broader and rounder. The slender bill is brown; the legs are light brown. Both sexes are similar.

Habits.—This bird is a common resident, though numbers migrate in the autumn, returning in the following spring. Large numbers also come to the south of England in the winter, returning to the north to breed. Family parties join to make large flocks.

The mistle-thrush haunts various districts—gardens, parks, woods, and, particularly, wild, hilly country. Its second name, "stormcock," is descriptive of its habit of singing wildly and joyously through gales and rain; it perches high on the swaying branches of a tall tree, loudly defying the elements. This vigorous song may be heard in almost any month, except when the bird is moulting. Like the blackbird, this thrush screams harshly when startled, and when defending its young it screeches and pecks furiously.

Insects and worms are eaten, but all sorts of berries are favoured—hawthorn, mistletoe, ivy, mountain-ash and juniper. The name *mistle-thrush* is said to have come from this bird's liking of the sticky, white mistletoe berries. The mistle-thrush shares the habit of its cousin, the song-thrush, in smashing snails on an "anvil." It is apt to oust the song-thrush from any locality in which it settles.

The flight is strong and direct with the tail outspread; the white under-parts and the white edges of the wing feathers can be then distinctly seen.

Breeding.—There are usually two broods. The birds breed very early in the year, their first nests sometimes being blown to pieces by winter storms. The site is varied, though in general fairly high up—a tall tree, a wall, a bush, or in a crevice of a seaside cliff. The nest is large and built of moss, grass, wool and roots, lined with hardened mud, and relined with soft grasses. Four or five greenish-white eggs are laid, mottled with dark brown or grey.

The Robin or Redbreast.—Length, $5\frac{3}{4}$ in. Wing, 3 in. This is a neat, trim little bird, standing very upright on rather long legs. The upper parts are brown; the distinguishing feature is the scarlet breast of both sexes. A blue-grey line divides the red breast from the dark back. The redbreast has bright black eyes, brown legs and a slender, black, pointed bill.

Habits.—This friendly little bird is universally loved, for it is apparently quite unafraid of man; indeed, it appears to seek his company. Every gardener will be familiar with the sight of a robin redbreast perching on the handle of his spade, or sitting, bright-eyed, on a stump close to where he is at work. The robin's movements are restless, spasmodic and fussy; it hops about, dips its head and body, tilts its head on one side, flirts its wings and generally makes a lively companion. The sweet, high-pitched song may be heard all the year round.

The chief food is worms, caterpillars, flies and various insects; some seeds are eaten and in domestic surroundings, bread-crumbs are favoured.

Although the robin delights in the haunts of man, many may be seen in hedgerows and lanes, where their inquiring little chirps and attractive, jerky bobbings bring them to our notice. It is very pugnacious towards other birds.

Breeding.—There are two or three broods. Various nesting-sites are chosen—a hole in a tree, wall or bank; an old shoe, a tin can, or the battered hat of a scarecrow. The large nest is built of grass, moss and leaves, and lined with hair and feathers. The five or six white eggs are mottled with light brown or red. The young have spotted breasts, which turn to the characteristic scarlet after the first moult.

The Blackbird.—Length, 10 in. Wing, 5 in. The plumage of the male is glossy black; the beak is bright orange. The female is dark-brown with a paler breast; her beak is brown. White or piebald black-birds occur.

Habits.—This bird is a resident in the British Isles and also a summer or winter visitor; some pass through Britain on their way to other breeding districts.

The blackbird is well known because it frequents public parks and

gardens ; but it is also plentiful in the country, and in winter may be seen flocking with other thrushes in the search for food. It is a shy bird and, when disturbed, rapidly retreats into a thicket, screaming loudly. In such cases, the characteristic flight is a low, swift dash for the nearest cover.

The actions are fussy ; the bird jerks and preens itself, quirking its tail gaily when alighting, and frightening off other birds by the loud scream with which it heralds its approach. The flight is straight and vigorous.

The food consists of worms, slugs and various insects ; the bird is extremely fond of fruit and may do considerable harm in a garden or orchard.

The blackbird sings chiefly in spring and summer, but the loud chatterings of alarm burst forth on the slightest provocation all through the year. It is a great fighter. Naturalists report that it will not only spar with rivals during the mating-season, but will even attack its own reflection in a window.

Breeding.—There are two or more broods. The nest, built usually in a hedge or tree, is made of grass lined with mud and relined with fine grass. Thus it may be distinguished from the song-thrush's nest, which has no inner lining. Four to six pale green eggs, finely dusted with dull red, are laid in March. The young birds are similar in colouring to the female, but lighter, with pale streaks a little darker than those of the thrush. The males obtain their orange beaks in the second year.

PLATE 3. BIRDS THAT LIKE FRUIT

Of the birds on this Plate, the redwing, the fieldfare and the ring-ousel belong to the Thrush Family (*Turdidæ*). The bullfinch and the hawfinch as their names imply, are of the Finch Family (*Fringillidæ*)†; the greater whitethroat is a Warbler (*Sylviidæ*). The *Sylviidæ* are small birds with weak, slender bills ; they feed on insects and fruit. The song is usually clear and sweet though sometimes metallic ; the nest is generally cup-shaped and contains from three to six whitish eggs.

The Greater Whitethroat.—Length, $5\frac{1}{2}$ in. Wing, $2\frac{3}{4}$ in. The general colouring is grey-brown, with the distinguishing feature of a white throat and chin. The head is blue-grey, the underparts are pinkish. The female is duller in colouring than the male and her underparts are whiter.

Habits.—The greater whitethroat is a summer visitor arriving early in April. It haunts the lanes and hedgerows, darting restlessly through

thickets with great skill, appearing at the top of the hedge and leaping off into the air to deliver its short song, then dipping down again into the hedge with fluttering wings. This bird has been picturesquely called the "nettle-creeper" on account of its skill in shooting through dense undergrowth.

The food is varied; insects are eaten in the summer, but berries are favoured when in season, elderberries particularly. In September and October, the birds leave Britain for their warmer winter homes.

Breeding.—There is one brood. The nesting-place is usually close to the ground, and the fragile cup, built of grass and small roots, is hidden in thick herbage. Four to six eggs are laid towards the end of May; they are whitish-green in colour, speckled with grey or red. The parents are anxious guardians. If the nest is approached, they flutter on the ground, pretending some injury in order to distract attention from the nestlings. The young are deep brown in colour with rusty wing feathers.

The Redwing.—Length, $8\frac{1}{2}$ in. Wing, $4\frac{1}{2}$ in. The head, back, and wings are brown; the underparts are white streaked with dark spots. The sides of the body and underneath the wing are shaded a tawny-red colour and there is a pale streak over the eye. The female is paler and duller in colour than the male.

Habits.—This bird is a winter visitor to the British Isles, arriving during September and October and departing to its northern home in April. Migration takes place at night.

The redwing is sociable, flocking with other thrushes to feed in the fields. The chief food is worms, molluscs of various kinds and insects; but when these become scarce during the winter months, berries and fruits are eaten. Redwings appear to suffer extremely during bad winters. Many are killed through lack of food, or through weakness caused by continual buffeting in their efforts to reach calmer districts.

In general, this is a shy and restless bird, though it becomes quite tame when driven by hunger.

The flight call is a soft note; when feeding, a gentle conversational note is uttered. The song is rarely heard in Britain—it is a quiet edition of the song-thrush's outburst.

Breeding.—The redwing breeds in its northern home and it is doubtful whether nests have been found in this country.

The Fieldfare.—Length, 10 in. Wing, $5\frac{3}{4}$ in. The head is slate-grey; the back is a rich chestnut-brown and the wings and tail are dark brown. The bird may be distinguished from the mistle-thrush, which it closely resembles, by the grey rump, which is conspicuous in flight against the dark wings and back. The underparts are whitish, with dark brown

markings. The bill is deep brown in winter and yellow in spring. The female is similar to the male but paler in colouring. In winter, the plumage is streaked with black, with white on the belly and under the wings. At a distance in a field, the birds then appear to be all black, white and grey.

Habits.—This bird, like the redwing, is a winter visitor to this country, arriving from September onwards and returning to its northern home in April.

The fieldfare is common in many parts of England in open fields, where large flocks may be seen, probably in company with other members of the *Thrush Family*. The bird is nomadic, moving from one spot to another as the food supply is used up. In very frosty weather, it may be seen on seashore marshes, or actually on the coast, where it eats small molluscs.

The food is similar to that of other thrushes—insects, worms and molluscs; berries are eaten, and of these the fieldfare shows particular preference for haws. Fieldfares scour ploughed fields in a characteristic fashion: a flock works steadily across the ground facing the wind, with repeated halts when each bird stands with head raised, erect and watchful. When startled, the birds quickly fly to the protection of trees. The song, like that of the redwing, is rarely heard in this country. The flight is straight, not particularly speedy, and high.

Breeding.—The fieldfare does not breed in the British Isles.

The Bullfinch.—Length, $6\frac{1}{4}$ in. Wing, 3 in. The back is grey-blue; the head is a dark, glossy blue-black; the underparts and the cheeks are a beautiful brick-red shading to white by the tail. The white wing-bar is conspicuous in flight. A distinguishing feature is the white patch on the blue-black tail.

The colour of the female is much duller than that of the male; the underparts are more brown than brick, though the white on the wings and under the tail is well marked. The bills of both sexes are short and thick.

Habits.—The bullfinch is our most handsome finch, but it is not well known as it is exceedingly shy, though generally distributed throughout the country.

It is a tree-loving bird and inhabits thick woodlands and hedgerows. During the spring it visits gardens and orchards, where it does much harm by eating or destroying the buds of fruit trees. The main food is the seeds of weeds, its strong bill being well adapted for crushing hard seed-coverings.

The bullfinch is one of the few birds that pairs for life; the male and the female are usually found together. The song is a gentle melody and

the male usually puffs out his breast feathers and sways his head from side to side as he sings. As with most Finches, the flight is undulating. •

Breeding.—There is usually one brood ; sometimes two. The nest is well hidden in a tree, shrub or hedge. It is a shallow cup, built of roots, twigs, etc., with a lining of fine roots nearly always black. The four to six eggs are blue-green marked on the larger end with purple or red. The young resemble the colour of the female but without the black on the head.

The Hawfinch.—Length, 7 in. Wing, 4 in. This finch is somewhat curious in appearance on account of its large head and bill, and short tail. The head and back are brownish ; the wings, blackish patched with white ; the nape, grey. The black tail is edged with white. The distinctive bill is lead-blue. There is a black patch running from the eye to the bill. The female is much paler in colour than the male.

Habits.—This, our largest finch, is a shy bird whose natural home is in dense wood, though it visits orchards and gardens when fruit is ripe. It has the habit of sitting upright on a bough, repeatedly turning its head from side to side. The flight is usually undulating, but when startled, it flies rapidly and directly, uttering a whistle-like call.

The hawfinch feeds mainly on the seeds and fruits of hawthorn, yew and sycamore ; hips, cherries and damsons are favoured. It has a large, cushion-shaped, horny pad on the roof of the mouth and beneath this pad a horny cushion on each side of the lower jaw ; this reinforcement enables the bird to crack cherry and other fruit stones, of which it is extremely fond. In gardens, this bird does much harm to peas, wrecking whole rows and leaving behind a dismal array of empty pods. During the breeding-season, however, the young are fed on harmful larvæ and insects.

Breeding.—There is one brood. The flat, loose nest is usually built high in a tree or spreading bush. Twigs, roots and lichen are used ; hair and other soft materials form the lining. The four to six white, or grey-green eggs are blotched with deep brown.

The Ring Ousel.—Length, 10 in. Wing, 4½ in. The male is sooty black with a white gorget. The bill is yellow ; the eye-rims, yellow ; the legs, brown. In winter, the breast feathers are tipped with grey and the bill becomes browner. The female is browner than the male ; the gorget is narrower and tinged slightly with light brown.

Habits.—This summer resident is chiefly found on moorlands and in hilly country such as the Lake District and in the Pennines. It is one of the earliest spring migrants, arriving in March from North Africa, or Southern Europe, where it spends the winter. Its habits are typical of a thrush ; it will flip its tail like a blackbird and is similarly alert and boisterous in character. • The song is wild and clear, somewhat similar to that

of the mistle-thrush ; the harsh chatter of alarm is similar to the blackbird's cry.

Breeding.—The nest is usually cleverly hidden in deep heather or behind a clump of thick grass ; it is a strong cup resembling that of the blackbird. Four to six eggs are laid in April or May ; they are similar to the blackbird's, being greenish with reddish-brown markings.

PLATE 4. SEED AND GRAIN EATERS

The birds on this Plate belong to various families but they are all characterised by the fact that seeds and grain form a main part of their diet. They are all *perching-birds*. The goldfinch, the greenfinch and the lesser redpoll belong to the Family *Fringillidæ*, of which mention has already been made. The wood pigeon (Family *Columbidæ*) belongs to the group of pigeons and doves. This group is arboreal in habit : the legs are short, the wings are large, the feet are strong and four-toed. The crop is particularly large and capable of being packed with a large amount of vegetable food which can be digested at leisure. The beak is short, the tip usually being somewhat thickened ; there is a thick rim to the eyelids and a soft area of skin around the nostrils. The young of pigeons and doves are usually hatched naked and helpless ; this serves as a protective measure and ensures that they cannot leave the high nest until their wings have developed.

The skylark belongs to the Family *Alaudidæ*, which includes about a hundred different larks. In most larks, the claw of the hind toe is very long ; the beak is usually short and the colouring is sober. Larks nest on the ground and lay white eggs, closely spotted with brown and grey.

The nuthatch (Family *Sittidæ*) is the one British member of this tribe. It spends most of its life running up and down and round and round tree trunks and branches, and, as will be seen, is peculiarly fitted for this life.

The Lesser Redpoll.—Length, $4\frac{1}{4}$ in. Wing, $2\frac{3}{4}$ in. The general colouring is brown with darker brown striations on the back and neck. The forehead and crown are crimson ; the chin is black ; the breast is pink ; the underparts are fawnish-white. There are two fawn bars on the wings. The female is similar in colouring to the male but lacks the pink breast. The colour resembles that of its close relation, the linnet, which has, however, no black on the chin.

Habits.—This bird is a common resident, though more plentiful in the north than in the south. Some of the birds migrate to the Continent for the nesting-season.

The lesser redpoll is an energetic and active bird. During the winter it is gregarious, keeping company with other birds in the search for food. When feeding, or flying, the birds twitter perpetually; the call-note is a simple one of two notes. The flight is a dancing, uneven bound.

The food consists chiefly of seeds of different plants, although insects are also eaten. Dandelion "clocks," grass seeds, etc., are favoured, the little bird performing all sorts of acrobatic feats as it searches out the seeds. It also haunts fruit trees and larches from which it picks out insect pests. Many lesser redpolls will gather on a birch or alder tree, hanging upside down and swaying this way and that as they pick out seeds.

Breeding.—There are usually two broods. The nest is built in a tree or hedge at varying heights from the ground; it is small and deep and constructed of twigs, grass, moss, thistledown, wool, etc. The four to six eggs are deep sea-green spotted with brownish-red. The young have no crimson on the head.

The Goldfinch.—Length, 5 in. Wing, 3 in. The head of this attractive bird is mostly red, white and black. The upper parts of the plumage are a warm brown; the underparts fawnish with deeper sides. The wings are black with a wide, bright yellow band—a distinguishing feature. The tail feathers are black with white spots and tips. Both male and female are similar.

Habits.—This beautiful finch is generally distributed, although rare far in the north. It inhabits gardens and parks, or waste ground where weeds abound. It is particularly fond of thistle seeds and a clump of seeding thistles will be almost sure to attract many of these charming birds, which will dance and flit from thistle-head to thistle-head, twittering constantly the while. The goldfinch is most useful in checking the spread of weeds. Besides the seeds of thistles it likes those of the knapweed and plants of the parsley tribe. Insects are also eaten, particularly in the spring when seeds are unavailable.

The beautiful song is loud and clear, somewhat similar to the canary's. Frequently, several goldfinches will gather together and sing in chorus. A flock of goldfinches is called a *charm*.

Breeding.—Two broods are usually reared. The nesting-place is often a tree in an orchard, although hedgerows are also favoured. The neat, compact nest is wonderfully made of twigs filled in with moss, lichen and wool, and lined with feathers and thistledown. The four to six eggs are bluish in colour with streaks or spots of purple or grey or brown. The young differ from their parents in that they lack the bright colourings of the head. The general colour is dull brown, striated with darker brown. They are popularly called "grey pates."

The Wood Pigeon or Ring-Dove.—Length, 16½ in. Wing, 9½ in. This large plump bird is blue-grey in colour with a deep lavender-coloured head. The wings and tail are darker ; the quills are edged with white. The feathers round the neck are beautifully shot with purple, green and blue ; there are large patches of white round the neck and a white bar on the wing. The bill is yellow ; the legs, red. The female is a little smaller than the male.

Habits.—The wood pigeon—or ring-dove as it is often called—is a familiar bird, for it inhabits not only the natural country woods, but is equally at home in the parks of large towns. During the autumn and winter, the large number of resident birds is increased by migrants from the Continent, which arrive in huge flocks and remain chiefly in the south of England until their departure in February or March.

Unfortunately, this attractive bird does immense harm to farm and garden crops. It is extremely greedy and almost every crop is attacked. It devours grain of all sorts, cabbages, swedes, potatoes, young cereals, turnips, peas, beans, cherries, currants, gooseberries, and many other crops. Weeds and their seeds are also eaten but the damage done far outweighs the good in this respect.

The tameness of town wood pigeons affords an excellent opportunity for studying the characteristics of the bird. It can be watched as it struts and bows, murmuring its well-known “ coo-cooo-coo, coo-coo.”

It nods its head as it walks, fluffs out its loose feathers, fans its tail or preens in the sunshine. The wings are large and strong. The loud clapping sound which is heard when an alarmed flock rises, is caused by a powerful down-beat of the wings and not by clapping the wings together as is popularly supposed.

The plumage of a wood pigeon is extremely loose and it is probable that these loose feathers serve as a protection by forming a cushion-like covering for the body. These birds have “ powder-downs,” patches of very soft feathers which produce a white powder as they break down. This powder is used by the bird in its toilet to waterproof the whole coat. A pigeon does not sip water after the manner of most birds ; it drinks.

Breeding.—There are two or three broods. The flimsy nest is usually built high in a tree or tall hedge. The unsubstantial platform of twisted twigs, which suffices for a nest, is sometimes so loosely made that the two glossy white, oval eggs can be seen from below. Both the male and female help in the incubation. The nestling, or “ squab,” is scantily covered in yellow down and it has a broad soft bill, which it pushes into its mother’s mouth to take the milk-like fluid she prepares for it by regurgitating digested food. This substance is known as “ pigeon’s milk.”

The Greenfinch or Green Linnet.—Length, 6 in. Wing, $3\frac{1}{2}$ in. The general colour of this bird is greenish with bright yellow margins to the wings and the base of the tail. The wings are greyish, deepening to dark brown. The strong beak is adapted for crushing seeds. The female's plumage is duller than the male's ; it is dark brown in the winter months.

Habits.—The greenfinch is both a resident and a migrant ; some birds leave England in September and return in the following spring ; others are birds of passage.

Greenfinches are sociable birds living together in large flocks. They commonly haunt waste ground and hedgerows, where they feed on the seeds of weeds, favouring charlock. They scratch about in stubble picking up fallen grain and they also visit the stackyards. In the spring, greenfinches may do considerable harm by eating young buds and germinating seeds.

The song is a gentle twittering with short trilling notes uttered when on the wing. A characteristic antic of the male is to fly into the air, sing a snatch of his twittering song, and then alight on his perch once more. After a brief pause this performance is repeated. The flight of the bird, like that of most finches, is undulating.

Breeding.—There are two or three broods. The rather large, loose nest is placed in a hedge or on the flat boughs of a conifer, and is built of twigs, moss, wool, grass, etc., and lined with hair or feathers. The four to six eggs are cream-coloured, spotted and streaked towards the large end with purple or brown. There is, however, some variety in the markings. The young birds are greyer in colour than their parents ; the back and breast are streaked with brown ; the bill is a fleshy-pink.

The Nuthatch.—Length, $5\frac{1}{2}$ in. Wing, $3\frac{1}{4}$ in. The upper parts of the plumage are bluish-grey ; the lower parts are fawn, paling to white on the chin ; the sides are a rich, chestnut-red. A noticeable black streak passes over the eye from the beak to the neck. The blue-grey tail is relieved with black and white. The female is duller in appearance than the male.

Habits.—The nuthatch is a resident bird and strictly arboreal in habit, its strong feet and claws being specially fitted for its life among trees. It runs up and down, and round and round the trunks, examining every crevice for insects, depending entirely upon its powerful feet for gripping and not, like the tree creeper, getting help from its tail, which is short and soft.

Though insects and their larvæ are eaten, the nuthatch, as its name indicates, is a nut-eater. It firmly wedges a nut into a crevice in the bark and hammers the shell with its powerful beak. Yew berries, beech-mast,

acorns and even hazel nuts are thus treated, the bird throwing its whole weight into the hammering when the shell is hard. Sometimes the nut-hatch tackles the job head downwards, the position in which the bird is believed to sleep.

This is a noisy bird with a boisterous, cheery whistle and a short running song.

Breeding.—There is one brood. The nest is usually built in a tree-hole of which the opening is, if necessary, plastered with mud to a convenient size. Inside, dead leaves, bits of bark, and grass form the resting-place for five to eight eggs. These are white with reddish spots.

PLATE 5. FLESH-EATING BIRDS

The birds on this Plate are *birds of prey*, the owls hunting by night and the hawks by day. As mentioned in the Introduction, this class of bird is characterised by the strong, down-curved beak and curved talons particularly suited to the method of obtaining food: further, owls have soft plumage, particularly the flight feathers, so that the wing-beat is muffled—an essential to a nocturnal hunter. The colouring of owls is in general sober; the eyes are strikingly beautiful, sometimes golden-yellow or deep hazel. The unusual shape of the face with both eyes looking forward and fringed with a disc of feathers is an adaptation to the nocturnal habits of owls. These birds are poor nest-builders and their eggs in general are pure white and round. Of the three owls shown on this

Plate, the barn owl belongs to the *Flammeidae* Family; the tawny owl and the little owl to the *Strigidae* Family.

The other two birds, the kestrel and the sparrow-hawk belong to the large family of hawks, harriers, eagles and falcons—*Falconidae*. These birds, like owls, have curved beaks and powerful curved talons. Their flight is swift and their eyesight remarkably keen. All birds of this group have an erect carriage; they have large crops where their food, which is usually rapidly gulped, can be stored and digested slowly. The females are in general larger than the males and the young are usually helpless when hatched.

The Kestrel—Length, 14 in. Wing, 9½ in. This is one of our smallest birds of prey. The back is reddish-brown, spotted with black; the



FIG. 7. Beak of hawk and foot of eagle.

underparts are buff, spotted and streaked with black; the head, rump and tail are blue-grey. The tail has a white tip, and a wide black bar at the end. The beak is slate-blue; the legs, yellow. There is a yellow circle round the eyes. The female is reddish-brown, with paler underparts streaked with black. The grey tail has several deep coloured bands in addition to the white streak and broad black bar. She lacks the blue-grey head and rump of the male.

Habits.—The kestrel, our most common falcon, may be found wherever there is the food for which it ceaselessly hunts. Heaths, moors, open fields, mountain-sides or coasts are equally favoured by this bird.

Small mammals, insects and caterpillars are chiefly eaten, and the bird performs a most useful service to man by its never-ending pursuit of mice. The kestrel does not bolt its food whole like the owls, but tears off lumps with its hooked beak. Undigested portions are regurgitated as solid pellets about the size of a walnut.

The kestrel affords a perfect example of hovering. The bird remains poised in the air with wings quivering, tail outspread, and head dropped. It glides forward, without extra movement of its wings, then hovers once again. Having sighted its quarry from on high, the bird dives headlong with shut wings, pauses almost on the earth's surface, seizes its prey in its strong talons and ascends rapidly. Most suitably, a common name for this bird is wind-hover. The extra wing-length, reaching beyond the tail, distinguishes it from the sparrow-hawk in the air.

Like most birds of prey, the kestrel is frequently mobbed by small birds, but it appears unperturbed by their angry fluttering and scolding. The cry is a clear screaming note uttered while on the wing.

Breeding.—There is one brood. The apology for a nest may be placed in the deserted nest of some other bird, or in a hollow in a ruin, a rock or an escarpment. Note in this connection that birds building high up, out of reach of attack, rarely build a well-constructed nest; cf. the nests of rooks, herons and gulls. Four or five eggs are laid in April or May; the ground colouring is dirty white, often hidden entirely by thick reddish mottlings. The young are covered at first with grey down.

The Little Owl.—Length, 9 in. Wing, 6 in. The upper parts of the plumage are brownish-grey, spotted and barred with white; the underparts are dirty-white striated with brown. The wings and tail are streaked alternately with white and brown. The eyes and beak are yellow and the facial disc is whitish. The male and female are similar.

Habits.—This, our smallest owl, is a resident bird, usually remaining in one spot. It is only during comparatively recent years that this bird has become established in this country through introduction by various

acorns and even hazel nuts are thus treated, the bird throwing its whole weight into the hammering when the shell is hard. Sometimes the nut-hatch tackles the job head downwards, the position in which the bird is believed to sleep.

This is a noisy bird with a boisterous, cheery whistle and a short running song.

Breeding.—There is one brood. The nest is usually built in a tree-hole of which the opening is, if necessary, plastered with mud to a convenient size. Inside, dead leaves, bits of bark, and grass form the resting-place for five to eight eggs. These are white with reddish spots.

PLATE 5. FLESH-EATING BIRDS

The birds on this Plate are *birds of prey*, the owls hunting by night and the hawks by day. As mentioned in the Introduction, this class of bird is characterised by the strong, down-curved beak and curved talons particularly suited to the method of obtaining food: further, owls have soft plumage, particularly the flight feathers, so that the wing-beat is muffled—an essential to a nocturnal hunter. The colouring of owls is in general sober; the eyes are strikingly beautiful, sometimes golden-yellow or deep hazel. The unusual shape of the face with both eyes looking forward and fringed with a disc of feathers is an adaptation to the nocturnal habits of owls. These birds are poor nest-builders and their eggs in general are pure white and round. Of the three owls shown on this Plate, the barn owl belongs to the *Flammeidae* Family; the tawny owl and the little owl to the *Strigidae* Family.

The other two birds, the kestrel and the sparrow-hawk belong to the large family of hawks, harriers, eagles and falcons—*Falconidae*. These birds, like owls, have curved beaks and powerful curved talons. Their flight is swift and their eyesight remarkably keen. All birds of this group have an erect carriage; they have large crops where their food, which is usually rapidly gulped, can be stored and digested slowly. The females are in general larger than the males and the young are usually helpless when hatched.

The Kestrel—Length, 14 in. Wing, 9½ in. This is one of our smallest birds of prey. The back is reddish-brown, spotted with black; the

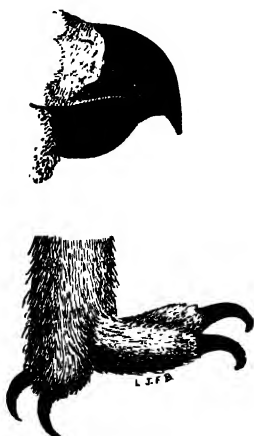


FIG. 7. Beak of hawk and foot of eagle.

underparts are buff, spotted and streaked with black; the head, rump and tail are blue-grey. The tail has a white tip, and a wide black bar at the end. The beak is slate-blue; the legs, yellow. There is a yellow circle round the eyes. The female is reddish-brown, with paler underparts streaked with black. The grey tail has several deep coloured bands in addition to the white streak and broad black bar. She lacks the blue-grey head and rump of the male.

Habits.—The kestrel, our most common falcon, may be found wherever there is the food for which it ceaselessly hunts. Heaths, moors, open fields, mountain-sides or coasts are equally favoured by this bird.

Small mammals, insects and caterpillars are chiefly eaten, and the bird performs a most useful service to man by its never-ending pursuit of mice. The kestrel does not bolt its food whole like the owls, but tears off lumps with its hooked beak. Undigested portions are regurgitated as solid pellets about the size of a walnut.

The kestrel affords a perfect example of hovering. The bird remains poised in the air with wings quivering, tail outspread, and head dropped. It glides forward, without extra movement of its wings, then hovers once again. Having sighted its quarry from on high, the bird dives headlong with shut wings, pauses almost on the earth's surface, seizes its prey in its strong talons and ascends rapidly. Most suitably, a common name for this bird is wind-hover. The extra wing-length, reaching beyond the tail, distinguishes it from the sparrow-hawk in the air.

Like most birds of prey, the kestrel is frequently mobbed by small birds, but it appears unperturbed by their angry fluttering and scolding. The cry is a clear screaming note uttered while on the wing.

Breeding.—There is one brood. The apology for a nest may be placed in the deserted nest of some other bird, or in a hollow in a ruin, a rock or an escarpment. Note in this connection that birds building high up, out of reach of attack, rarely build a well-constructed nest; cf. the nests of rooks, herons and gulls. Four or five eggs are laid in April or May; the ground colouring is dirty white, often hidden entirely by thick reddish mottlings. The young are covered at first with grey down.

The Little Owl.—Length, 9 in. Wing, 6 in. The upper parts of the plumage are brownish-grey, spotted and barred with white; the underparts are dirty-white striated with brown. The wings and tail are streaked alternately with white and brown. The eyes and beak are yellow and the facial disc is whitish. The male and female are similar.

Habits.—This, our smallest owl, is a resident bird, usually remaining in one spot. It is only during comparatively recent years that this bird has become established in this country through introduction by various

people. Once settled, it increased so rapidly in numbers that it is now in some districts the most common owl. It is spreading from the Midlands where it was first introduced. The little owl haunts well-wooded districts, and may be seen hunting for food both during the day and night.

The food is chiefly large insects, earthworms, mice, shrews and beetles. Useful insect-eating birds are also killed and the little owl does much harm in game preserves and poultry farms where it not only steals the eggs but takes the young chicks. However, it must be remembered that the little owl does useful work by preying on various pests.

The call is somewhat like a mew—"ciu, ciu, ciu." The flight is jerky and appears indecisive. When perching, the bird sits upright.

Breeding.—There is one brood. The nesting-place is usually in some hole, and the four to six white oval eggs are laid in April or May.

The Barn Owl.—Length, 14 in. Wing, 11½ in. The upper parts of the plumage are tawny-buff mottled with grey and white spots; the underparts are white, with occasional large greyish spots. The wide, flat face is white. The feathered legs are long; the toes splay out except when perching, when two go to the front and two behind; the talons are sharp and strong. The watchful eyes are a deep hazel.

Habits.—The barn owl is a common resident in Britain. It haunts the dwellings of man, living in barns, old ruins, or trees near a farmhouse. It is a nocturnal bird, flying silently through the dusk on its regular nightly round, when it appears as a ghostly white shape, the pale underparts only being visible. It may be seen roosting during daylight when it sits bolt upright with its eyes apparently closed, although in fact, the bird is acutely observing the intruder. It will follow his movements by turning the head without moving the body or legs—indeed, the barn owl can nearly turn its head back to front.

The chief food is rats, mice, fish, moles, shrews, and other small animals. Roosting house sparrows are also captured and eaten; indeed, the barn owl may justly be termed the "best friend" of the farmer. The prey is swallowed complete; later, the bones, skin and other indigestible portions are regurgitated in the form of pellets—"plugs."

Barn owls emit loud, piercing screams as they swoop through the dusk. From this noise, most unnerving when it comes apparently from nowhere, the bird is sometimes called the *screech owl*.

The barn owl is a bad-tempered bird; it will snap its hooked beak, hiss, lower its head, droop its pinions menacingly and sway to and fro in anger.

Breeding.—There are two broods. The nesting-place is in barns, in holes of trees, church towers, ruins, etc. No nest is made; the four to

eight pure white eggs are placed on the flat. These eggs are laid at intervals of several days ; they are incubated together, and thus eggs and young birds (owlets) may be found in the same nest at once. The young are covered with a thick coat of white down, from which the beak and eyes poke out.

The Brown Owl.—Length, 15 in. Wing, 10 in. The general colouring of this bird is rusty-fawn mottled with deep brown. The wings are barred with paler feathers. The underparts are buff streaked with dark brown. The facial disc is a brownish-grey ; the eyes are very dark, almost black ; the bill is yellowish. The legs are feathered down to the toes. The female is larger than the male and more rusty in colouring.

Habits.—This is a resident bird, the largest of our native owls, and it haunts the woodlands. (Other names are *wood owl*, and *tawny owl*.) It rarely ventures abroad during daylight, but remains roosting close to the trunk of a tree, or in the hollow of a branch, with eyes half closed. The hearing is exceptionally acute, and, like the barn owl, it keeps a close watch on any intruder. In common with most birds of prey, the brown owl is furiously mobbed by smaller birds.

The food consists of the usual small mammals, birds and insects ; squirrels and young rabbits are also eaten ; surface-swimming fish are captured. The brown owl, on account of its beneficial work in destroying rodents, is a most helpful bird to farmers.

The call is the well-known, wavering “tu-whit, tu-whoo ;” the flight note is a sharp “ki-wik, ki-wik.” The bird is fierce and will sometimes attack human beings who venture too close to the nest.

Breeding.—The nesting-place is often in a hollow tree, or a hole in a building, or sometimes in the old nest of some other bird. Three or four large, pure white eggs are laid at intervals. The young are at first covered with thick white down ; later, the plumage becomes streaked and barred with fawn.

The Sparrow-Hawk.—Length, 13 in. Wing, 8 in. The upper parts of the male are blue-grey with a white spot at the back of the neck. The wing and tail feathers are deep brown with grey bands. The beak is slate blue ; the legs and eyes, yellow. The underparts are a rusty colour with brown-red, close, wavy bars.

The female is markedly different. Length, 15 in. Wing, 9½ in. The upper parts are brown-grey with a white spot on the neck ; the underparts are white, barred with brown or dark grey.

Habits.—This bird is a widely distributed resident, haunting cliffs, open country, woods and heaths. When hunting, it flies low nearby hedges or copses, sweeping rapidly along and dashing suddenly upon any

unwary bird. Often, the sparrow-hawk will choose a bird from a flock and chase it. So excited and bold does it become during the chase, that several instances are recorded of both bird and prey crashing into a window, or through an open doorway. This terror of small birds is often mobbed, but it cleverly avoids any actual attack, for it is agile and incredibly swift on the wing. Small birds are the chief prey, but the fierce and daring sparrow-hawk will attack a wood pigeon, or swoop down into a poultry farm and kill a grown hen. Mice, frogs, and various large insects are also devoured. The bird eats its prey on the ground, planting both feet on the quarry and ripping up the flesh. The cry is a harsh screaming " mew."

Breeding.—A tree is the usual nesting-place. The flat nest of twigs is built for preference on some ready-made foundation, such as a squirrel's drey. Four to six eggs are laid in May; they are blue-green with bold markings of deep reddish-brown, though these vary considerably. The young are dark brown with white underparts, brown-barred. They are extremely bad-tempered and fierce.

PLATE 6. BIRDS OF THE WOODLANDS

The birds on this Plate belong to various families but they are linked by the fact that they are all arboreal species, preferring densely wooded areas. The two woodpeckers belong to the *Picidæ Family* and they are interesting examples of adaptation of structure to food and habit. Ants form a great part of their diet; thus they are provided with long tongues with which to lick up these small insects. Enlarged salivary glands secrete a very sticky fluid which makes the tongue even better suited to its purpose. The beak is sharp and pick-like; the feet are strong and provided with powerful curved claws for clinging to the bark. The " yoke toes " (two in front and two behind) give additional strength. The tail is specially interesting, the shafts of the feathers being modified into strong spikes, thus giving the bird a third " leg " or " seat " for additional support as it hangs on the trunk of a tree. The birds of this family are handsome and often brightly coloured.

The tree creeper (*Certhiidae*) spends most of its life running round and round tree trunks in search of insects. Creepers have 'stiffened tails similar to woodpeckers'; they feed on insects which they pick up with their long, slim beaks. Nearly all the creepers are demurely feathered.

The nightingale and redstart belong to the Thrush Family (*Turdidae*) of which mention has already been made. (Plate 2.)

The nightjar (*Caprimulgidae*) is one of a fairly large group. These birds are nocturnal in habit; they are soberly clad and have large eyes.

Their beaks are very short and delicate but their mouths are huge and enfringed by bristles to assist in the catching of insects on the wing.

The Redstart.—Length, $5\frac{1}{2}$ in. Wing, 3 in. This pretty bird has a grey head and upper parts, with bright chestnut tail, chest and flanks. The cheeks and throat are black ; the forehead, white. The underparts shade from chestnut to almost white. The wings are brown. The female is generally browner than the male with pale underparts and no black on the throat.

Habits.—In April the redstarts arrive and seek their haunts in woodlands, near ruins, or where there are ancient trees, affording suitable nesting-places. The bird is much like the robin in its jerky movements, the tail bobbing or “starting” continuously, the body jumping up and down. The rich chestnut tail is most conspicuous in flight ; the white forehead is another distinguishing feature.

The food is chiefly insects, which the redstart catches on the wing, dodging and flitting about in the air, and plunging down into long grasses where small winged insects are always plentiful.

The song is short and cheery ; sometimes the bird will sing on the wing and sometimes after dark.

Breeding.—There is rarely more than one brood. The nesting-place may be in various sites—a hole in a tree, nooks and crannies in quarries or overhanging rocks, a hole in the ground, or the lintel of an old building. In each case, the loose, grassy cup is well concealed. The eggs are light blue and may be from five to eight in number. The young are mottled, but they, too, have the bright chestnut tail.

The Lesser Spotted Woodpecker.—Length, $5\frac{1}{2}$ in. Wing, $3\frac{1}{2}$ in. The top part of the back is black ; the lower part is striped with black and white. The wing and tail feathers are strongly barred. The underparts are white, with striated sides. In the male, the top of the head is crimson ; both sexes have black stripes over the eyes and from the beak to the neck. The female’s head is whitish ; eyes, crimson ; beak and legs, blue-grey.

Habits.—This small bird is the rarest of the three British woodpeckers. It lives in woodlands, parks, orchards, etc., but it is shy and keeps mainly to the tops of the trees. At night, it will roost in a hole.

The food is chiefly insects that attack trees, and in destroying them this woodpecker is extremely useful. It chips away soft and decaying wood, feasting on the harmful larvæ underneath ; often the little heaps of wood chips show where this bird has been at work. Small chipped patches on tree trunks also indicate its presence.

Besides the light tapping sound caused by chipping away soft wood, the woodpecker makes a sound known as “drumming.” This sound may



FIG. 8. Beak, tongue and foot of woodpecker.

often be heard from a great distance. It is made by a series of rapid blows on the bark with the beak.

Breeding.—There is one brood. The nesting-place is a hole bored in soft or decaying wood. At the base of the tunnel a small chamber is carved out, and in this the five to eight glossy white eggs are laid upon a few wood chips.

The Green Woodpecker.—Length, $12\frac{1}{2}$ in. Wing, $6\frac{1}{2}$ in. The general colouring of the plumage is green, dark green above, yellow-green below. The top of the head and back of the neck are crimson. There is a black moustachial stripe, the centre of which, in the male, is crimson. There is black round the eyes. The yoke-toed feet are blue-grey.

Habits.—The shy green woodpecker haunts woodlands where, when seen, it is unmistakable on account of its striking appearance and its characteristic pose as it clings upright to the side of a tree trunk. The bird moves diagonally upwards in a series of jerky runs and leaps, tapping the bark assiduously the while, probably searching for some hollow where insects may lurk. The woodpecker cannot run downwards like the nut-hatch, but it can move backwards a little, tail foremost.

The food is mainly those insects which burrow into the barks of trees—beetles and various grubs. The bird is extremely fond of ants, and will destroy an entire ant-hill with its strong, long beak, trapping the insects with its long, sticky tongue. In the autumn, the bird eats nuts and berries. It is particularly fond of wood-lice and is thus most helpful to agriculturists.

The call is a cheery, laughter-like one, giving the bird its local name, *yaffle*. The flight is jerky.

Breeding.—There is one brood. The nesting-place is a hole in a tree, which the bird bores with its strong, sharp beak. The hole is round and neat, and runs straight in for a short way, then turns downwards for a depth of about eight or twelve inches. Five to seven glossy white eggs are laid in April or May, no material other than a few wood chips being used to make a bedding. Both male and female young have the crimson moustaches; they are streaked and spotted all over.

The Tree Creeper.—Length, 5 in. Wing, $2\frac{1}{2}$ in. The upper parts are dark brown, streaked with rust and white, and the underparts are

silver-grey. The tail feathers are stiff and pointed ; the large feet are very strong for climbing trees. The bill is long and curved with a needle-sharp point. There is little difference between the sexes.

Habits.—This resident bird lives almost entirely in trees, although in winter it will venture into more open country in search of food.

The bird scurries up tree trunks in a rapid, jerky way, now darting sideways to probe some interesting-looking crack, then running upwards a little, and again darting sideways. It runs along the underside of branches, for it is as much at ease upside-down as in any other position. The stiff tail feathers help to give an extra support in its gymnastics. The bird is a useful one on account of the many harmful insects it devours. These it picks out of fissures in the bark with its slim, long, curved beak.

The call is shrill ; the song is soft and simple and may be heard during the winter months. The flight is undulating and easy.

Breeding.—There are often two broods. The nesting-place is usually in a fissure or hole in the bark, or between thick ivy and a wall. The nest is built of grass, moss, fine strips of bark, wool, feathers, down, etc. Five to nine white eggs, spotted with rust and grey at the larger end, are laid in late April or May.

The Nightingale.—Length, $5\frac{1}{2}$ in. Wing, $3\frac{1}{2}$ in. This is a plain bird, brown above and greyish-white below. With its bright eye and trim body, the nightingale much resembles the robin, but it has not the same perky stance and appears to be slimmer. Both sexes are alike.

Habits.—The nightingale is a spring migrant, reaching England in April and leaving towards the end of August. It haunts copses, hedgerows and bushy, wooded areas.

The nightingale is specially noted for its song which is a marvellous outburst of liquid notes rising quickly in a loud, trilling crescendo. A far-away, ghostly note following a pause is specially characteristic. The reputation of this song is most likely due to the fact that the nightingale sings as jubilantly by the light of the moon as by the light of day, and as night songsters are rare we cannot help but listen in delight to its outpourings. During singing, the whole body quivers with effort. The song period is very short ; as soon as the young are hatched the notes lose their beauty.

The food is entirely composed of insects and berries.

Breeding.—There is one brood. The nesting-place is carefully hidden and is usually on or close to the ground. Four to six green-blue or olive-brown eggs are laid in the deep, grassy nest. The young are redder in colour than their parents and are mottled on the underparts.

The Nightjar.—Length, $10\frac{1}{2}$ in. .Wing, $7\frac{1}{2}$ in. The general plumage is mottled grey and brown with buff and black streaks. There is white on the tail feathers, on the throat and wings. The female has no white. The legs are short, the head is flat and the beak small. The gape is huge and the mouth is fringed with bristles.

Habits.—Probably because this interesting bird is a night-flier, a good deal of superstition has been connected with it and its habits. Some of its local names—"goat-sucker" and "night-hawk" are two—indicate the strange beliefs of some country people. This is unfortunate, because the nightjar is a most useful bird and should be encouraged. It certainly does not suck milk from goats, nor does it hawk anything at night other than insects, moths and larvæ, many of them harmful.

The nightjar is a summer resident, appearing during May. Entirely nocturnal in habit, except when disturbed, this bird is not frequently seen, though its strange "jarring" note may often be heard coming from the woods during a summer night.

The food consists entirely of insects which are caught on the wing. Dor-beetles, cockchafers, crane-flies and many night moths are snapped up. The very wide gape and the bristles surrounding the mouth help in the aerial capture of these night-flying creatures.

The flight is swift and agile and as silent as an owl's. When flying, the nightjar sometimes makes a noise like a pistol shot, which it has been said is caused by clapping the wings together. Some naturalists, however, affirm that such soft-feathered wings could not produce this sound, which they attribute to a strong down-beat, rather like the lash of a whip.

This bird is unique amongst British birds in that it perches *along* a branch instead of *across* it. During the daytime, it often crouches close to the ground, so well concealed by its dull colouring that it is almost invisible.

Breeding.—One brood is usual; there may be two. No nest is made, the two oval, mottled eggs being placed on the bare ground, sufficiently camouflaged by their protective markings. The young birds are covered with grey and brown down, livid blue skin showing on the naked neck and beak.

PLATE 7. LARGE OMNIVOROUS BIRDS

All the birds on this Plate belong to the Crow Family (*Corvidæ*). These birds are mostly large; they have stout beaks, and they are strong in flight. Crows seem to be intelligent birds: many members of the family can be taught to speak; some are wily in their habits. Their food

varies slightly from one member to another, but in general they are omnivorous—that is, they will eat anything.

The Jay.—Length, about 15 in. Wing, 7 in. The general colour of the plumage is a warm brown, the throat and rump being white. The wings are black, white and chestnut-brown with very bright blue barred feathers on the coverts. The tail is brown-black. The jay has a black-and-white streaked crest on the head.

Habits.—The beautiful jay is fairly common in many parts of the country but this is due more to its cunning than to anything else, for it is severely persecuted by gamekeepers, farmers and gardeners. It is constantly on the watch for enemies on the one hand and unwary victims on the other. It is extremely shy and often all that can be seen is the flash of white on its rump as it flies heavily from tree to tree. It is a noisy bird, uttering a harsh screech except in the breeding-season when it is quiet.

The food is varied. It eats acorns and nuts of various kinds; snails, worms, peas, wheat and orchard fruits are sought and eagerly devoured. In the spring, the jay steals the eggs and sometimes the young of other birds and may do much harm in a game preserve. However, besides destroying much that is of value to man, the jay also helps to get rid of pests.

This bird is intelligent and makes an amusing pet. The song notes of other birds may often be detected in its own medley of song, and some jays have been taught to speak certain words. Like the magpie, this bird buries nuts and other treasures.

Breeding.—There is one brood. The well-hidden nest is usually placed in a small tree, or in the hedgerow. The eggs are small for so large a bird and are light grey-green in colour, sometimes speckled with light brown. Five or six eggs are usually laid.

The Rook.—Length, about 19 in. Wing, 12 $\frac{3}{4}$ in. The colour is all black with a gloss of blue, green and violet. The adult rook has a bald patch of grey skin at the base of the beak.

Habits.—This gregarious, resident bird is widely distributed throughout Britain; in addition, many rooks are winter or summer visitors. It is one of our best-known birds, its characteristic homeward flight in the evening and its noisy “cawing” being essential parts of the English countryside.

The rook is most sociable in its habits, feeding in great flocks, and nesting in colonies. Rookeries are common; the large untidy nests are placed in clumps of tall trees from which the straggling, croaking flock slowly flies to a field under the plough, to strut along in the furrows searching for food in the newly-turned soil.

The food is varied. Like other crows, the rook likes flesh and small

mammals ; molluscs, worms, and various insects are avidly eaten. The rook is especially fond of the harmful "leather-jacket" and in devouring this pest does good work for the farmer. Its liking for grain and root crops count in its disfavour ; but in general it may be said that so long as the numbers are kept within reasonable limits the rook is a helpful bird, destroying many pests. Rooks are very conversational birds and a rookery in springtime is a constant tumult of activity and chatter.

Breeding.—There is one brood. The nest is large and built of twigs, cemented together with clods of earth. Many nests are built in the same tree and old ones are repaired for the new season, fresh sticks being added until the nests become huge. Three to six greenish eggs are laid.

The Carrion Crow.—Length, about 20 in. Wing, 13 in. The general plumage is black with a glossy sheen of green or purple. There are bristle-like feathers at the base of the strong beak. The female is smaller than the male but otherwise similar.

Habits.—The carrion crow is often confused with the rook, though in habits, if not in actual appearance, the birds are quite different. The carrion crow is solitary in its habits ; rooks are generally gregarious birds. The beak of the crow is shorter and stouter, and is covered with bristle-like feathers at the base. The rook has a bare patch of skin at the base of its beak.

By nature the crow is cautious and shy, although it becomes daring enough when searching for its food. Crows may often be seen, solitary, big, black birds, slowly and deliberately winging their way over a field, always on the watch for prey. As its name implies, the bird will eat carrion (dead creatures) of all kinds ; but it will also catch, kill and devour any small animal, and it is a cunning egg-thief. Poultry farmers and gamekeepers rightly dislike this bird ; on the whole the carrion crow does more harm than good and it should certainly not be encouraged. The carrion crow is fond of molluscs and may often be found haunting the seashore. When a shellfish is too tightly closed to be opened, the bird will carry it to a height and drop it time and time again until the shell is shattered.

The call of the carrion crow is a harsh croaking sound.

Breeding.—There is one brood. The big nest, built of twigs cemented with earth, may be built on a cliff ledge, or high up in a tall



FIG. 9. Beak and foot of crow

tree. The four or five greenish eggs may be spotted with a darker colour. The young are similar to the parents, but lack the gloss on the feathers.

The Magpie.—Length, about 18 in. Wing, $7\frac{1}{2}$ in. This distinctive, pied bird has a head, neck and breast of shining black, glossed with metallic green, blue and violet. The underparts and shoulders are white; the wings and long tail are black, shot with bright colours. In flight, white wing feathers are conspicuous. The male is a little larger than the female, but otherwise the birds are similar.

Habits.—The magpie is an exceedingly shy bird, but it may be frequently seen slipping through trees in wooded country. In winter, magpies flock together for food and roost at night in small companies.

The food consists of fruit, insects, birds, mice, moles, rats, snails, worms, grain and acorns. The bird does much harm in game preserves for it is an inveterate egg-thief; but it does good by checking the numbers of pests such as mice, rats, and certain harmful insects. On the whole, the magpie is a useful bird providing that its activities are controlled.

The beak is strong, as is the case with all crows. The flight is rapid. On the ground, the magpie usually walks carefully, carrying its long tail clear of the earth; in flight, the length of tail is also conspicuous. Its love of bright objects is well known—the birds will steal and hide thimbles, coins, keys or any other shining object. Magpies make interesting, though mischievous, pets and can be taught to say various words and phrases.

Breeding.—There is one brood. The nest is placed in a tall tree. It is domed and built of twigs, grass, roots and other materials, cemented together with earth. Over all, the arch of sticks cleverly conceals the opening. Five to eight eggs may be laid, often blue-green speckled with olive-brown. The young are similar to the parents, but lack the gloss on the black feathers.

The Jackdaw.—Length, about 14 in. Wing, $9\frac{1}{4}$ in. The general colour is black with a bluish sheen on the head and upper parts. Adult birds have a grey patch on the back of the head and neck. The legs and bill are black.

Habits.—A resident throughout the British Isles, this bird is popular on account of its sociability. The jackdaw may be seen near cliffs, in parks and woods, round old ruined buildings, or in the open country searching for food. It often joins flocks of rooks and starlings.

The food is varied—earthworms, molluscs and insects of all kinds; mice, fruit, grain, and eggs and young birds in spring are also devoured. The jackdaw is fond of the ticks which bury themselves in the skin of sheep, and to obtain these, the birds perch on the sheep's back.

In flight, jackdaws beat their wings rapidly, quite differently from

the deliberate wing-beat of the rook. They indulge in aerobatics of various kinds, especially at mating-time, when a whole colony will sweep, dive, twist and turn in the air, chattering loudly the while. The cry—"Jack-jack-jack"—gives them their name. Jackdaws make good, but mischievous, pets. They can be taught to speak most cleverly.

Breeding.—There is one brood. Jackdaws almost invariably nest in colonies in cliff faces, church towers, or on old ruins. Four to six eggs are laid, bluish-green in colour and spotted lightly with a darker tint. The young are browner in colour than their parents and the patch of grey is at first hardly noticeable.

PLATE 8. BIRDS OF THE WATERSIDE—I

The birds on this Plate belong to various families. The heron belongs to the *Ardeidæ Family* (Hérons). These are tall, *wading-birds* with long legs. The bills are strong and straight; the hind toes are long and low down, on the same level as the front toes. The claw of the middle toe is comb-like, though it is not known whether it serves any purpose.

The great crested grebe (*Podicipidæ*) is a *diving-bird*. The grebes are almost entirely water-birds, generally coming to the shore only for breeding purposes, and then the nest is built to float at the edge of the water. The wings are broad and curved; the toes are lobed, almost frilled, but not joined by web like those of many water-birds.

The coot and the moorhen belong to the *Rallidæ Family*. In this family, the birds are in general fairly narrow and they are able to slip easily between reeds and marsh vegetation. The toes are usually lobed and well developed. The wings and tail are small and the flight is not generally very strong. These birds are excellent swimmers and divers.

The dipper (*Cinclidæ Family*) is unique among *perching-birds*, for it can swim and dive splendidly. It is wren-like in its poise. With no apparent modifications of its legs and feet (though the toes are long) it can run about under water clinging to stones as it searches for food. Dippers usually build their nests very close to water—sometimes even in a crack behind a waterfall.

The Dipper.—Length, 7 in. Wing, $3\frac{3}{4}$ in. The head is brown; the back is deep slate-grey mottled with black, so that the bird looks black from a distance. A distinguishing feature is the white chest and throat, with a broad chestnut-red band just in front of the legs. This band merges into black. The legs are long.

Habits.—The dipper lives in and near running streams or lakes. It

gets its name from the habit of dipping its beak up and down as it perches on rocks half-buried in water.

The dipper is a good diver and swims under water in the same way as it flies through the air—by flapping its wings. Sometimes, it scrambles about on the river-bed searching for various larvæ and water-dwelling insects, clinging to rocks and stones with its large feet.

The food consists chiefly of aquatic creatures, and the bird is exceedingly fond of the “water-flea,” a destructive pest to the ova of trout ; thus the dipper may well be called a friend of the fisherman. It walks or runs on the land, searching out various insects.

It is remarkable that this little bird is not apparently specially adapted to its watery habits. The toes are long and strong and the feathers are very thick and tufty close to the skin ; but apart from these, there appear to be no particular modifications.

The dipper has a soft but sweet song. The flight is swift.

Breeding.—There are two or three broods. The untidy nest is domed and built of leaves, moss, dead plants, and so on. It is often placed under a bridge or in the crevice of a rock—sometimes it is so close to the water that it is partially submerged. Inside the untidy outer covering is a neat cup of grass, the entrance to which is usually well concealed. The four to six pure white eggs are laid in March or April. The young are brownish-grey in colour and lack the chestnut band. They readily fall into the water and dive for safety, even when scarcely fledged.

The Moorhen.—Length, 13 in. Wing, 6½ in. The general plumage of this bird is slate-black with chocolate-coloured wings and white on the flanks. The base of the bill has a boss or plate of bright red ; in adult birds the tip is yellow. The legs are greenish ; the toes widely splayed, with a slight flange or flattened edge.

Habits.—The moorhen is a common waterside resident in the British Isles. It is a possessive bird and usually only a pair will be found in any one spot.

Moorhens are not good fliers, but they are excellent swimmers, progressing jerkily with flitting, bobbing movements of the head. When frightened, a moorhen scrambles over the water half-flying, half-paddling. Its long toes help it to walk over water-lily leaves and other spreading water-plants.

The moorhen dives frequently in search of food ; it swims under water and often remains near the bank with its body submerged, only the tip of its bill sticking out of the water. The food consists of small fish and various water-creatures and the fleshy under-water stems of aquatic plants. On land, slugs, snails and worms are eaten.

The bird walks daintily with high-stepping sharp movements, quirking its tail and bobbing its head, as when swimming. The male birds are most quarrelsome at mating-times and their fierce battles often end in injury to one or other of the combatants.

Breeding.—There are two or even three broods. The nest is usually placed among rushes by the waterside, but it may be farther inland among long grass, in a low bush, or even in a tree. Six to ten reddish-yellow eggs, spotted with brownish-orange, are laid. The long-legged nestlings are covered with black down; the crown is bluish and at the base of the orange bill is a bright red patch. The nestlings can swim as soon as they are hatched; it is said, that they use their wings as “hands” to enable them to scramble into the nest.

The Heron.—Length, 37 in. Wing, 17½ in. The general colouring of this large bird is grey. A prominent black stripe over the eye continues into a trailing black crest. There are black markings on the throat and chest; the flight feathers are almost black. There are egret-like plumes on the wings and chest. The forehead is white; the bill is yellow; the legs are long and yellow.

Habits.—This beautiful water-bird is a resident in the British Isles, though it is not common. It haunts both salt and fresh water—any place where food is to be found.

The heron is a patient fisherman, standing in the water on one leg, head drawn down, keen eyes on the watch for a fish. As soon as the prey is sighted, the apparently dreaming bird shoots out its long neck with amazing swiftness and grasps the victim in its long, strong beak. At other times, the bird will solemnly stalk through the water, dashing out to seize any unwary frog, or water-creature. Mice, rats and young wildfowl are also eaten.

The flight of a heron is slow and deliberate; the bird wheels gracefully on outstretched wings with the long legs trailing behind. The neck is curved backwards until the head rests on the shoulders.

Hérons possess the curious tufts of feathers known as “powder-downs.” These look somewhat woolly, but when touched they leave a very fine powdery dust, used by the bird in its toilet for water-proofing its feathers. In the heron, these “powder-downs”

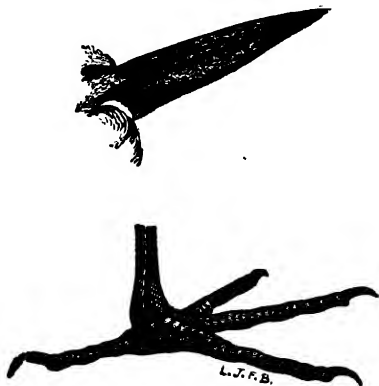


FIG. 10. Beak and foot of heron.

occur on the chest and thighs, giving the feathers a beautiful "bloom."

Breeding.—There is one brood. Herons are generally gregarious in their nesting-habits, the huge platforms of twigs being placed close together at the top of tall trees. These nesting-colonies are called "heronries." Four or five greenish-blue eggs are laid early in March. The nestlings are ugly, half-naked little creatures with short thick bills which are used to assist in climbing about the branches of the trees and for scrambling over the huge nests.

The Coot.—Length, 15 in. Wing, $8\frac{1}{2}$ in. The general plumage of this bird is smoke-grey with black on the head and neck, and a white plate on the forehead. The wing is narrowly barred with white. The legs are greyish with lobed toes; the eyes are reddish; the bill is white.

Habits.—This resident bird is found in most parts of the British Isles on meres, lakes, slow-flowing rivers and sometimes by the coast.

The coot lives chiefly on the water: unlike the moorhen it does not spend much of its time on land. It swims with a swift bobbing movement; when frightened, it splashes rapidly over the surface of the water before rising to fly. This bird frequently dives and swims well with both feet at once, though usually it does not remain submerged for long at a time.

The coot is a great fighter. It appears to sit upon the water on its tail, attacking with feet and wings. But although this bird is ill-tempered, it is gregarious by nature and in winter large numbers of coots may be seen together.

The food consists of small fish and various water-creatures; the fleshy under-water stems of aquatic plants are also eaten.

Breeding.—There is one brood. The large, ungainly nest is often built among water-plants, additions of sedges and reeds being made if the water should rise and threaten to cover it. The seven to twelve or more grey speckled eggs are laid late in April or early in May. The nestling is a downy, sooty-black little creature with a vivid red head, orange cheeks and blue crown. It can swim almost as soon as hatched.

The Great Crested Grebe.—Length, 21 in. Wing, $7\frac{1}{2}$ in. This slim diving-bird is distinctive in appearance on account of the raised grey-brown crest and the ruff round the neck. The general colouring is grey-brown on the upper parts and snowy-white underneath. The head is rich chestnut. The neck is long and snaky in appearance; the bill is long and sharp. The legs are green; the eyes are crimson.

Habits.—This bird has greatly increased in numbers within recent years and is common in Cheshire and Shropshire and on the Norfolk

Broads. When swimming, the white underparts are rarely visible, as the great crested grebe crouches low in the water. Sometimes the neck may be curved backwards so that the head rests upon the back ; but the usual position when swimming is for the neck to be held upright.

Although the bird can swim swiftly over the water, its speed under water is far greater. It rarely flies, though sometimes it may migrate from one mere to another. In flight the white wing bar is most conspicuous.

The food consists of various aquatic creatures and small fish, which latter is the food chiefly fed to the young.

The great crested grebe indulges in various antics on the water, especially at mating-time. It frequently preens its feathers and rolls sideways, when the silky white underparts are shown. During the breeding-season the grebe utters a harsh scraping cry.

Breeding.—There are one or two broods. The nest is a large floating construction of reeds and various water-plants anchored to waterside sedges. Three greenish eggs are laid. The nestling is covered with brownish and black-striped down ; the crown is a pinkish colour and in front is a bright red triangular patch. At first the little birds are carried on the back of one or other of the parents.

PLATE 9. BIRDS OF THE WATERSIDE—II

Of the birds on this Plate, the teal, widgeon and mallard are the most aquatic. They belong to the Family of Geese, Swans and Ducks (*Anatidæ*) and may be observed in many large parks. These birds have interesting modifications for their way of life, the greater part of which is spent actually on the water. Their feet are webbed, as are the feet of most *swimming-birds*, and their bills are broad and flat, fringed with grooves (*lamellæ*). The fleshy tongue is also provided with lamellæ which, together with those on the beak, make a " sieve " to keep back the small aquatic creatures from the mouthfuls of water and mud which the birds take in. The beak is not horny, as with other birds, but the bony frame is covered with a layer of skin. An interesting fact about these birds is that the nest is warmly lined with down plucked from the female's breast.

There is one part of the wing feathers of ducks which is much the same in each species. It is the glossy green or blue part edged with white. This patch of colour is a distinguishing mark of the Duck Family. It is called the " mirror," or the *speculum*, on account of its brightness.

The two warblers, the sedge and the reed, belong to the *Sylviidæ* Family of which mention has already been made. (Plate 3.)

The reed bunting is a finch (*Fringillidæ* Family). (Plate 1.)

The kingfisher (*Alcedinidæ Family*) is the only British example of this family, most members of which are brilliantly hued. They have long, strong beaks admirably suited to fishing; short legs and frail toes. The front toes are united but the tips are free.

The Reed Warbler.—Length, $5\frac{1}{4}$ in. Wing, $2\frac{1}{2}$ in. The upper parts of the plumage are brownish, merging well with the withering reeds among which the bird lives. The underparts are white, the flanks rufous.

Habits.—This bird is a summer migrant, arriving in this country towards the end of April and in May. Its chief haunts are among the reed-beds of the south and the midlands.

This is a shy bird which is chiefly active at night; moreover, the densely-growing reeds render it difficult to detect. It hops daintily from one stem to another, often perching sideways with bent legs, or creeping sideways up a stem to the top, where it will give forth a burst of song. Like all warblers, this bird is most garrulous and will twitter all day and sometimes at night. The reed warbler, like the sedge warbler, is a mimic.

The food consists of insects, quantities of which are to be found in the damp atmosphere of the reed-beds.

Breeding.—There is one brood. The beautifully constructed nest is built round the stems of two, three or four reeds, usually those actually growing from the water. The nest is deep and strongly woven of grass, sedges, wool, reed flowers, hair, and so on. The four or five eggs are greenish-white and plentifully marked with dark blotches. The cuckoo sometimes lays her eggs in the nests of the reed warblers, and a pair of these small birds may sometimes be seen working hard to appease the enormous appetite of their large foster-child.

The Reed Bunting.—Length, about 6 in. Wing, 3 in. The head and throat of the male bird are black with a white streak from the bill to the broad white collar. The upper parts are a warm chestnut-brown; the underparts are white, streaked with brown on the flanks. The white on the outer tail feathers is prominent.

The female is smaller than the male and her general colour is lighter. The head is brown, not black, and there is no black on the throat.

Habits.—The reed bunting may be either a resident or a migrant, and it lives beside both flowing or still water. Marshy ground is a favourite haunt of the birds, for there is found an abundance of insects which are their chief food. In winter, seeds of various kinds are eaten.

A characteristic habit of the bird is to cling to the stem of a reed, chirruping continually. On the ground the reed bunting both walks and hops. Its flight is similar to that of most finches, but markedly spasmodic.

In winter, the birds flock with other buntings and with finches.

Breeding.—There are two and often three broods. The nest is usually placed near the base of the reeds and is made of dry grass, bits of reeds, flags, moss, etc., and is lined with hair and the feathery awns of the reeds.

The Kingfisher.—Length, $7\frac{1}{2}$ in. Wing, 3 in. The upper plumage of this beautiful bird is enamelled blue with greenish reflections on the wings and head. The underparts and the ear-coverts are rich chestnut-red ; the chin and the sides of the neck are white. The bill is strong and long ; the tail is short, giving the bird a somewhat unbalanced appearance when perching.

Habits.—The kingfisher is a resident bird. By nature it is shy, and generally only a glimpse of it is seen as it flashes down-stream like a living gem. It haunts the waterside in search of various aquatic insects ; it also catches surface-swimming fish. In winter, when inland waters may be frozen, the kingfisher visits the seashore and tidal marshes seeking for fish, aquatic insects and crustacea.

The kingfisher usually has a favourite perch where it sits silently watching the waters below until the prey is sighted, when the bird plunges swiftly into the water to secure its wriggling victim. Large fish are smashed on a bough, but small ones are swallowed immediately, the bird usually tossing them into the air and gulping them down head-first.

Breeding.—There are usually two broods. The nest is placed at the end of a tunnel excavated in a clay or loamy bank, usually over water. The tunnel, which is about three feet long, slopes slightly upwards and at the end is the rounded nesting-chamber. There are six to eight round, white, glossy eggs. The young are covered with bluish stub feathers ; when they finally emerge from the nest they are similar to their parents, but duller in colour. The presence of the kingfisher's nest may generally be known by the unpleasant smell of fish bones and decomposing remains of fish.

The Mallard.—Length, 23 in. Wing, 11 in. The handsome drake has a glossy, bottle-green head and neck, a deep chestnut breast, and grey body. There is a white ring round the lower part of the neck. The wings are grey with a purple speculum shot with green and edged with white. The tail feathers curl upwards.

The duck is smaller and more drab in colour than the drake, being mottled brown and buff. The speculum is similar to that of the male.

Habits.—The mallard, or wild duck, is both a resident and a winter visitor. It haunts moors, marshes, lakes or shores and is a gregarious bird at all seasons. The usual feeding-time is at dawn or dusk ; the day-

time is spent in flocks, resting or sleeping or wandering about picking up odd insects on the bank.

Mallards pair for life, and in the evening they join up in their couples and fly out to seek for food. The mallard is an omnivorous bird and both animal and vegetable food is sifted from pond water through the bill. It eats grain, insects, acorns, snails and slugs, shellfish, ripe berries and so on. When inland waters are frozen, the mallard usually goes to the coast, where crustacea are to be had. It sometimes "upends" in the search for food, but it is not a good diver.

The flight is both swift and strong; often the swishing of wings can plainly be heard as a flock flies overhead. Both male and female "quack," the male's note being deeper and more resonant than the female's.

During August, the drakes moult and go into hiding because they lose all their flight feathers together and thus are defenceless.

Breeding.—There is one brood. The nest is usually hidden in thick undergrowth near water, though it may be in the fork of a tree. Grasses, dead leaves and other materials are used, and the lining is composed of brown down plucked from the breast. Eight to fourteen greenish-blue, cream, or white eggs are laid. The ducklings are brownish in colour with occasional white patches and a dark streak across the eye.

The Sedge Warbler.—Length, $4\frac{3}{4}$ in. Wing, $2\frac{1}{2}$ in. The general colour of this bird is reddish-brown with dark streaks on the upper parts. The underparts are buff, shading to the reddish rump. A conspicuous light streak over the eye forms a distinguishing mark.

Habits.—This bird is a summer resident in the British Isles and is one of the most common of the marsh warblers. It lives anywhere near water, as its food consists of various insects—part of whose life is spent in water—midges, gnats, and so on. Small molluscs and larvæ of moths and beetles are also eaten.

The sedge warbler is not so often seen as heard. It has a favourite perch among the undergrowth, where it will sit and sing all day long and sometimes far into the night. The notes of various other birds are introduced into the song, for the sedge warbler is a clever mimic.

Breeding.—There is usually only one brood. The neat little nest of grass is generally placed low in a bush or in tangled undergrowth near water. Horsehair or the downy plumes of willow-herb form the lining. Five or six green eggs, speckled with brown, are laid. The nestlings are redder than their parents, with a faintly spotted throat and breast.

The Widgeon.—Length, $18\frac{1}{2}$ in. Wing, 10 in. The head and neck of the drake are warm chestnut with a yellowish crown. The greyish upper parts and flanks are divided by a white line, and the greenish-blue

speculum is edged with velvet black. The burnt-pink colour of the breast shades to white and delicate grey.

The duck is more soberly clad than the drake ; it is mottled grey and brown with a greenish-blue speculum.

Habits.—The widgeon is a common winter visitor to most parts of the British Isles. It nests in Northern Scotland, but not farther south. It is normally a salt-water duck, but sometimes haunts inland lakes.

In a sandy bay, thousands of widgeon may be seen floating on the water, or pulling up sea-grass, their chief food. This grows plentifully on shores where the out-going tide leaves an expanse of muddy ground. Molluscs, various insects and marine worms are also eaten, and grain and berries are sometimes taken when nothing else is available.

The widgeon, unlike most ducks, walks and runs easily on land. It is swift in flight. The drake's call is a long, sweet whistle.

Breeding.—There is one brood. The nest, which is usually placed close to water, is built of dead water-plants and grasses and lined with down. There are six to ten creamy-white eggs. The ducklings are covered with soft, brown down, slightly reddish on the neck.

The Teal.—Length, 14 to 15 in. Wing, $7\frac{1}{2}$ in. The drake has a rich chestnut-coloured head with a bottle-green patch edged with buff running from the eye to the neck. The breast is buff spotted with black ; there is a yellowish patch on the rump. A noticeable feature is the longitudinal white line bordered with a black line on the wing. The speculum is metallic green and velvety black. The duck is chiefly buff mottled with brown ; the green speculum is bordered with white.

Habits.—The teal, our smallest duck, is both a winter visitor and a resident. It lives generally by fresh water where there is plenty of cover, though flocks may be seen on salt-water estuaries. It feeds chiefly at dawn and dusk, though it may spend the day in shallow water to feed on minute crustacea and vegetable substances, which are sifted through its laminated bill.

During the day, teals pass a good deal of time dozing on the water or squatting on the bank. When alarmed, a flock rises with amazing speed straight into the air. The birds keep together, turning and twisting, diving downwards and shooting upwards with remarkable precision. When alighting, the birds plunge downwards with great speed, checking themselves near water by thrusting forward their feet and tails and spreading out their fluttering wings.

Teals are very talkative birds, the flocks keeping up a constant conversation interspersed with loud clear whistles as they swim about on the water.

Breeding.—There is one brood. In marshes, the nest is placed on the ground ; on moors, it may be among the heath. It is built of rushes, grass, etc., and is lined with down. The eight to twelve eggs are a creamy colour with a faint tinge of green. The ducklings are covered with down, light brown above and buff below.

PLATE 10. BIRDS OF THE MARSH AND HEATH

The birds on this Plate usually nest on heathland or in marshy districts. Out of the breeding-season, however, they frequently inhabit the shore. They are all *wading-birds*.

The common snipe and the dunlin belong to the Sub-Family *Scolopacinae*. Characteristic features of this tribe are the long bills, curved or straight, and the long legs. The typical plumage is pale and dark brown in streaks ; a colour which harmonises with the birds' surroundings. Worms form the chief food and for these the birds probe the ground with their long bills.

The curlew, the redshank and the common sandpiper (Sub-Family *Totaninae*) are well-known examples of their tribe. Characteristics of this family are the long legs, the long bills and the joining of the front toes at their bases. The colouring varies ; some species are protectively coloured while others are much brighter.

The plovers (*Charadriinae*) form a large group of which the lapwing is a common member. These birds have short beaks ; the legs are of medium length and the hind toe is usually missing.

The Redshank.—Length, 12 in. Wing, 6½ in. The upper parts of the plumage are brown, speckled and streaked with darker brown ; the neck is paler in colour and plainly streaked on the back with dark brown ; the underparts and throat are white. The long legs are orange-red.

Habits.—This bird is both a resident and a winter visitor to all parts of our coasts. It haunts watery districts—shores, marshes, grasslands, mud-flats and frequently, sewage-farms.

This is a very noisy, restless bird which, when feeding, bobs and dips its head and breast continuously. Insects and molluscs are its chief food. The long beak enables the bird to pick out seaworms and crustacea from muddy shores, and insects and worms from marshy ground. It is a good swimmer.

The redshank is always on the alert and quick to take alarm when it will fly swiftly and unevenly, crying loudly the while. In flight the broad white bands in the wings are most noticeable.

Breeding.—There is one brood. The nest is often well hidden among

the surrounding grass, the parent birds weaving the tops of the grasses together to make a screen. The eggs, usually four in number, are varied in colouring; they are often cream-coloured with dark brown markings.

The Common Snipe.—Length, $10\frac{1}{2}$ in. Wing, 5 in. The general plumage is mottled brown. The back is dark brown with lighter streaks; the head is dark with buff streaks; the wings are mottled and streaked with black, brown and buff. The underparts are whitish, barred with light brown on the flanks. The beak is very long.

Habits.—This bird is both a resident and a winter visitor. It haunts the moors and marshes, where it remains in hiding during the day, coming out at dusk to feed. Then, one by one, the birds rise from the ground with a cry and sweep away to the edges of ponds, bogs or other places where with their long sensitive bills they prod for worms in the soft ground. The bill is most remarkable; the tip is swollen and the upper mandible can be raised or lowered at will, thus, when the snipe finds a worm underground, it can force its beak apart so that the prey can be seized and withdrawn. Although insects and worms form the staple diet, seeds may be eaten in hard weather.

The snipe makes a curious sound which may frequently be heard during the mating-season. The bird rises rapidly with strong beats of its wing, then swoops down with half-opened wings and with widespread tail. The outer pairs of tail feathers stand apart from the rest, and in the downward rush these feathers vibrate, causing a light “booming” sound. When alarmed, the snipe has a characteristic zig-zag flight, very swift and irregular.

Breeding.—There is one brood. The nest is a grassy cup well concealed in long grasses or among heather. Four eggs are usually laid and placed with their small ends pointing inwards. They are greenish in colour with dark brown smudges. The nestlings are covered with brown-red down conspicuously barred with black and dark brown speckled with white. They trust to their colouring for protection and remain “frozen,” even when closely approached. They can run well soon after they are hatched, but the parents feed them for some time and it is a pretty sight to see them conducting their downy offspring to a feeding-place, strutting along ahead and calling to them with frequent cries. •

The Dunlin.—Length, $7\frac{1}{2}$ in. Wing, $4\frac{1}{2}$ in. In summer the general colouring of this bird is brown-red mottled with black. There is ash-grey on the wings; the upper part of the breast is buffish with darker streaks. The underparts are black, the sides and underneath the tail are white. In winter the upper parts are grey with some darker markings on the wings, and the underparts are white. •

Habits.—This, one of the commonest of shore birds, is a resident, a summer visitor, a winter visitor and a bird of passage. The favourite haunts of the birds are sandbanks, sandy shores, or the muddy estuaries of rivers; at mating-time they go to high moorlands for nesting.

At the time of migration, great hosts of dunlins may be seen clustering along the shore. Flocks of these birds are most interesting to watch; they mass together, then spread out; they rise to a considerable height, then shoot downwards, every bird manœuvring at the same moment. When a flock of dunlins passes overhead, the rushing noise of the wings is remarkable.

When feeding, dunlins scatter widely over the shore, face to the wind, wading about shallow pools, heads forward as they probe into the muddy slush to extract small marine creatures. The beak is similar to that of the snipe, in that the upper jaw can be moved from the lower when the bill is in the soil. During the nesting-season, when the dunlin repairs to high moorland, insects are chiefly eaten.

Breeding.—There is one brood. The neat, grassy nest is sometimes well hidden; at other times hardly concealed at all. The eggs are laid in May or June. These vary, but generally they are brownish or yellow with darker markings massed towards the thick end. The nestlings are covered with chestnut-coloured down flecked with black and white; the underparts are white.

The Curlew.—Length, 23 in. Wing, 12 in. This bird has a plump body with very long beak and legs. The head, back and breast are mottled with buff and dark brown; the wings and tail are streaked with light and dark brown. The underparts are whitish with light brown spots. There is a pale eye-stripe. The legs are greenish and the very long bill is brown.

Habits.—In moorland districts this bird is a common resident, and in coastal regions it is a bird of passage and a summer or winter visitor. At mating-time, the pairs retreat to their nesting-places on the moors, but during the autumn and winter they are most common on seashore flats or on the shore itself. At all times gregarious, great flocks may be seen crowding the shore at high tide, and when migration takes place the numbers are often enormous. The flight is

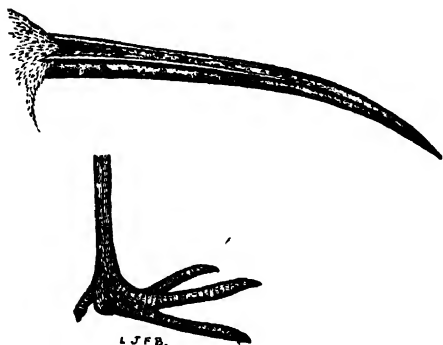


FIG. 11. Beak and foot of curlew.

speedy and the flocks travel in V-shaped formation or in neat lines.

Interesting changes of diet occur. On the moors, insects and worms and moorland berries are eaten, the blackberry and the whinberry being especially favoured. In winter, however, when the birds come to the coast, they eat shore molluscs or small sea-creatures, apparently easily altering their diet to suit their change of circumstances. The bill, which may vary in length from four inches to seven, can be pushed into muddy soil to pick out an insect.

The curlew is a noisy bird, its mournful, piercing cry being uttered repeatedly. It can swim well, though it is chiefly a wader.

Breeding.—There is one brood. The apology for a nest is situated high on the moors and is placed among the dense tussocks of ling or moorland grass. Three or four large pear-shaped eggs are laid, yellowish-white in colour and plentifully marked with brown at the wide end. The nestlings are covered with pale brownish down mottled with chestnut and brown, and they are fairly well protected by this colouring.

The Lapwing.—Length, 12 in. Wing, 8½ in. The crest, head, throat and chest of this bird are black; the back and wings are enamelled green with a purplish gloss, though in the distance the general effect is black. The sides of the neck, the underparts and the black-banded tail are white. Under the tail is a rich, chestnut-red patch. The legs are red. The female's crest is shorter than that of the male.

Habits.—This is both a resident bird and a partial migrant. It haunts marshes, fields, or downland; it may go down to the shores in search of food; it will flock in cultivated fields, or it may join with the curlew far away on high moors.

The lapwing is a useful bird, destroying many wireworms and harmful larvæ, which it seems to prefer to the beneficial worms. It also eats the water-snails which are hosts of the harmful liver-fluke that causes liver-rot in sheep.

The lapwing's call, a mournful "pee-wee," has given the bird its other common name, *peewit*.

Breeding.—There is one brood. The site is in the open and the nest is almost non-existent, merely a small scraped hollow. Four eggs are usually laid; they are dark olive in colour, heavily mottled and placed with the small ends pointing inwards, an arrangement which facilitates sitting. When ap-



FIG. 12. Head and foot of lapwing.

proached, the hen lapwing feigns injury, trailing one wing as if broken, to draw intruders away from the nest. The nestlings are reddish with black markings ; they are white underneath.

The Sandpiper.—Length, 8 in. Wing, $4\frac{1}{2}$ in. The general colour of the plumage is brownish on the upper parts with darker spots. A conspicuous white bar in the wing shows in flight. The underparts are white ; there is a white line above the eye and white on the outer tail feathers.

Habits.—This bird is a summer visitor to the British Isles, nesting in Scotland and in the northern counties of England. It haunts lonely districts such as wide lakes, pools, lowlands and hillside streams. Late in the summer the birds leave these northern haunts and make for lower regions, including the seashore. Later, migration begins, often at night.

The sandpiper wades about in the water catching small shellfish, worms and various larvæ. When alarmed it stands still, bobbing its tail and nodding its head ; then it will suddenly fly away across the water in a semi-circular direction. During the flight the drawn-out quavering whistle of the bird may be heard.

The long thin legs are typical of a wading-bird, and the long beak enables it to extract small creatures from slushy ground.

Breeding.—There is one brood. The nest is usually placed on the ground close to water. It is well built of leaves, dry grasses and moss ; at other times it may be a mere depression in the ground. The four eggs are buffish, shiny and lightly speckled. The young birds are covered with pale down marked with black.

PLATE II. BIRDS IN WINTER—TITMICE

Perhaps the most popular group of birds is the titmice (*Paridæ Family*). They become quite tame in winter when hunger forces them to seek food and water in gardens, parks, and other districts close to our homes. Particularly, they are charming birds to watch with their ceaseless activity, their dainty movements and their churring chatter. No bird is a more eager and frequent visitor to a garden bird table than one or other of the tits, and if half a coconut is hung from a tree, these little birds will provide endless delight by their acrobatics as they swing upside-down to pick out the sweet kernel.

The habits of all the tits are similar, as is the food which consists chiefly of insects. The birds are most helpful in destroying many harmful insect pests, but they also have a liking for fruit buds, although naturalists state that only those buds which contain some " worm " are torn in order

to get at the creature inside. Tits run and hop agilely about the hedgerows and up tree trunks and branches, peering in the furrows of the bark for hidden insects, swinging from one leg to snap up a suspended leaf-miner, and twittering frequently. They are mostly nomadic and gregarious, though there are many tiffs and skirmishes among the little flocks as they flutter round the bird table.

Every means should be taken to encourage these pretty and useful little birds. Winter feeding is very helpful and instructions for arranging a suitable bird table are given in the Introduction. Tits particularly like to peck at suspended lumps of fat, bacon rind, nuts, or any odds and ends from the kitchen. It is a good plan to plant some sunflowers in the garden, for the birds are fond of the seeds. Where these seeds are to be had, the tits are less likely to peck holes in ripe fruit, as they sometimes do.

Another way of helping tits is to provide them with suitable nesting-boxes. Care should be taken that these are out of the way of cats. The trunk of a tree is the best situation but a pergola or the wall of a shed will do well. The box must be weather-proof and firmly fixed to its support. It should not be placed in full sunshine, as young birds suffer from excessive heat, and it should, if possible, tilt slightly forwards for dryness. The roof should in any event be sloping and should have a good overhang.

Care should be taken over the details of construction or the results will be unsuccessful. A good size for a nesting-box for tits is 8 in. high by 4 in. wide by 4 in. deep. The entrance hole should be made as high as possible and *not in the middle*. The diameter of the hole should not exceed $1\frac{1}{2}$ in. or sparrows and other birds may claim the box. The rougher the wood used in the construction the better, so long as the finished article is weather-proof.

The Blue Titmouse.—Length, $4\frac{1}{3}$ in. Wing, $2\frac{1}{2}$ in. The crown is blue, the cheeks are white, encircled and traversed by a dark line; the underparts are yellow. There is a conspicuous white bar on the wings, which are blue, as are the back and tail.

The blue titmouse is specially valuable as a destroyer of garden pests. Seeds are also eaten and it is said that bees are favoured.

The nest is made in a hole in a tree, a gate-post, or in a nesting-box and, as blue titmice will return year after year to the same nesting-place, it is well worth encouraging them. The nest is made of dry grasses, moss, hair, wool and other soft materials. The number of eggs varies and may be great—as many as twenty have been recorded, but eight is a normal number. They are small and white with faint reddish markings at the larger end. The young are much more yellow than their parents.

The Great Titmouse.—Length, $7\frac{1}{4}$ in. Wing, 3 in. This bird is

considerably larger than the blue, and the head is black instead of blue. The cheeks are white, and the black of the head continues round the cheeks to the chin. The back is olive-green, the tail and wings are blue-grey; the underparts are yellow. There is a white bar on the wings; the outer tail feathers have white edges. The distinguishing feature of the bird is the long black "waistcoat" or line from chin to vent.

This bird has a varied diet of spiders and all sorts of insects; seeds and even nuts are cracked and the contents devoured.

Any hole may serve as a nesting-place, where grasses, leaves and a soft lining of hair, fur or feathers are rapidly woven together. Seven is a normal number of eggs, which resemble the blue tit's, though fifteen have been recorded. The young are duller in colour than their parents.

The Coal Titmouse.—Length, $4\frac{1}{4}$ in. Wing, $2\frac{1}{2}$ in. The distinguishing mark of the coal titmouse is a large white spot on the nape of the black head. The cheeks are white, the throat black; the back and wings are brownish-olive; the underparts are buffish. There is a white bar on the wings.

The food is similar to that of other tits—insect pests and seeds; it is particularly fond of beech-mast and the seeds inside cones.

The nest is built for preference in the hole of a rotting tree-stump, usually deep down. Sometimes a rabbit's burrow or a squirrel's drey may be appropriated. Moss, grasses and hair are closely woven together and lined with rabbit's fur or feathers. Seven to eleven eggs are laid; they are similar to the blue tit's. The young birds are duller in colour than their parents, the white on the nape and cheeks being shaded with yellow.

The Long-tailed Titmouse.—Length, $5\frac{1}{2}$ in. Wing, $2\frac{1}{2}$ in. This bird is easily distinguished on account of its long tail which makes up for almost half its length. The head is whitish with a black band over each eye, extending to the neck and over the back. The shoulders are pinkish, the wings and tail brownish with white margins on many of the feathers. The underparts are whitish, shading to pink on the sides. The long tail is most useful in helping the bird to balance as it performs its antics; the flight is short.

The food is chiefly insects.

The nest is most beautiful—an oval, domed construction which takes both birds about a fortnight to make. It is situated in a hedge or some similar place and shredded moss, lichen, wool, and spider's web silk are carefully woven together until a thick oval dome is made. The inside is massed with little feathers and amongst these the eight to twelve eggs are laid. The sitting bird puts her tail over her head so that all that can be

seen of her is the tail tip and the head looking out of the round entrance hole in the middle of the nest. The congestion in the nest is often made worse at night-time when the male may enter to roost, for these birds are susceptible to the cold. The young are duller in colour than their parents and at first their tails are short.

The Marsh Titmouse.—Length, $4\frac{1}{2}$ in. Wing, $2\frac{1}{2}$ in. The head is blue-black, the chin black, and the cheeks white. The upper parts are olive-brown; the underparts are buff. The wings and tail are brownish. The absence of a white wing-bar helps to distinguish this bird from the coal tit; it also lacks the distinctive white nape of the coal tit.

The marsh tit not only inhabits marshes, as its name implies, but it is often found in woods, hedges, and gardens. Its habits are similar to those of the other tits; it is fond of seeds as well as of insect pests in the garden.

The marsh tit is more of a tree species than its cousins, and though the nest may be in a hole in the ground, it may equally well be made in a hole in a tall tree or a tree stump. Fur, moss, wool and hair are woven together, with willow-down sometimes used as a lining. The usual tit type of egg is laid late in April or May. The young are duller in colouring than their parents.

PLATE 12. BIRDS OF THE ROCKY COAST

All the birds on this Plate haunt rocky coasts. Their lives are, in a greater or lesser degree, aquatic, and accordingly there are marked modifications in structure. In all these birds the feet are webbed, the legs very short, and the beaks, though differing in form, are powerful. All are fish-eaters.

The cormorant (*Phalacrocoracidae* Family) is closely related to the gannet (*Sulidae* Family). The members of the Gannet Family are powerful in flight, possessing long pointed wings. They are excellent divers, by which means they obtain their food. The cormorants have more limited powers of flight; indeed, one species has entirely lost this power. Members of the Cormorant Family have sharply hooked beaks; those of the Gannet Family are dagger-like. Both families have no external nostrils; all four toes are connected by webbing.

The other three birds on the Plate, the razorbill, the puffin and the guillemot, belong to the *Alcidae* Family—the auks. These are diving-birds, stocky in build with short wings. The legs are very short and set far back; the foot is webbed, and there is no hind toe. A skeleton of an auk shows an interesting development of the ribs which are so long that



FIG. 13. Great Auk (after a wash drawing by Daniel King, *circa* 1652).
This bird is now extinct.

they entirely protect the whole abdomen. Auks come to land only when necessary for breeding. The remainder of their lives is spent afloat.

The Razor-bill.—Length, 17 in. Wing, $8\frac{1}{2}$ in. The adult has black, glossy upper parts; white underparts, and a white wing bar. The bill is black and flattened sideways; its appearance is somewhat hooked. It is grooved lengthways, the deepest groove being lined with white from the tip of the beak to the eye. In winter, the throat and face of the bird are white.

Habits.—This bird is called a “resident” of the British Isles, though actually the greater part of its life is spent on the water. It comes to our shores for nesting only, unless unwillingly driven thither by storms and the consequent difficulty of obtaining food afloat.

When swimming, the razor-bill looks somewhat like a small black-and-white duck, bobbing cork-like on the crest of the waves with pointed tail held slightly up. Under water, the bird “flies” with open wings, using its feet as rudders for turning. Fish are captured under water and swallowed on the spot unless the young are to be fed, when several fish are carried crosswise in the bill. Although the wings are short, the flight is rapid. The note is a growling croak. Razor-bills on land are clumsy; they walk very little, and when resting they sit on the whole of the foot.

Razor-bills are often found in company with guillemots.

Breeding.—There is one brood. Razor-bills nest in large colonies on



FIG. 14. Beak and foot of gannet.

cliff-sides, the single eggs being placed under an overhanging ledge. The egg is blue, greenish, white or yellow and is covered with dark streaks, smudges and blotches. The razor-bill squats lengthways to incubate the egg.

The Gannet.—Length, about 37 in. Wing, 19 in. The general plumage is white with buffish shadings on the back of the head and the neck. The quill feathers are dark brown. The skin surrounding the eye is dark blue-black; the legs are greenish and the feet are webbed. The young are dark-coloured and do not acquire the full white plumage for four years.

Habits.—These fine, white birds are to be seen along our shores all through the year; at nesting-time their numbers are immense.

The birds are excellent fliers, swimmers and divers. In the air, the great expanse of wing keeps the gannet floating lightly as it watches for fish in the water below. When a victim is sighted, the bird plunges down with closed wings at terrific speed, diving into the water with a mighty splash. The force of the impact with the water is broken by a mass of air-cells just underneath the skin which act like a protective cushion to the body. The prey is caught and swallowed under water. Herring, mackerel and other shoal-fish are the chief victims.

In spring and summer vast colonies of gannets can be seen on coastal cliffs. Thousands of birds perch on the crags, thousands more wheel overhead, and others send constant spurts of water into the air as they dive in search of food. They return to the cliffs with terrific speed, at the last moment throwing their wings forward to check themselves.

Breeding.—There is one brood. Gannets nest in colonies and, like many birds of this habit, stealing is a common offence and the colony is perpetually noisy with quarrels and fights. The nest is made of seaweed or cliff vegetation, and one egg is laid, greenish beneath a chalky outer layer. The bird puts both feet over the egg before lowering the body for incubation—a strange habit. At first, the young are both blind and naked, but they soon grow a covering of woolly down. They feed by putting their heads—and sometimes most of their small bodies, too—into the parents' throats for regurgitated fish.

The Cormorant.—Length, about 36 in. Wing, $14\frac{3}{4}$ in. The general colour of the plumage is black glossed with green and bronze. The feathers on the back of the neck are long, thus forming a shaggy

mane. The chin and lower part of the face are white and there is a white patch on the thighs. The bare skin surrounding the beak and the pouch, is yellow.

Habits.—This bird breeds chiefly on rocky coasts, but it is common along any shore and may also be found by inland waters.

The cormorant is an excellent swimmer and diver. Under water, the legs strike simultaneously and the bird proceeds in jerks, the head held back ready to shoot out at the prey. The fish are overtaken under water, and brought to the surface where they are swallowed whole, their progress down the long, elastic neck being easily seen.

On the rocks, rows of cormorants stand stretching out their wings to dry, or they waddle awkwardly along with swaying necks. Inland, they sit on railings, their webbed feet curled round the bar and their wings slightly opened for balancing. The note is a harsh croaking.

In flight, the legs trail out behind and the long, thin neck is extended. When flying by the shore, the bird usually skims low over the waves, but inland it ascends to a great height, wheeling and swooping with open wings.

Breeding.—There is one brood. The birds usually breed in colonies, the seaweed nests being frequently of enormous size and placed many together on a ledge close to the sea. Inland, the nests are made of sticks, and lined with green grasses. Three or four rough, chalky or bluish eggs are laid in April or May. The young are naked and extremely ugly; they push their beaks into the parents' to fish for half-digested food. Later, they are covered with sooty down.

The Guillemot.—Length, 18½ in. Wing, 7¾ in. The upper parts of the plumage are brown; the underparts and a bar across the wings are white. The bill is black, long and pointed. In winter, the feathers are browner and the face and throat are white.

Habits.—The guillemot lives entirely on the sea during the winter, though storms often result in many being washed up to the shore, dead or exhausted. This is largely due to lack of food and not on account of buffeting by waves. Storms cause fish to descend to deeper waters where there is less disturbance, the supply of food for guillemots, razor-bills and other pelagic birds thus being cut off with disastrous results.

The bird swims well, and it is a good and swift diver, catching and eating fish under the water. Like the razor-bill, it uses its wings for swimming under water, its feet acting as rudders. The flight is straight and rapid.

In the breeding-season, multitudes of guillemots flock to flat cliff-tops where they sit in rows, perpetually quarrelling and jostling as more arrive.

Breeding.—There is one brood. The egg is placed on a ledge and the bird incubates it either sitting upright or lying flat. The egg varies considerably; it may be green, blue, yellowish-cream, white, brown or red; the blotches and smudges may be of any colour and variously distributed. It is markedly pyriform in shape so that winds blowing along the exposed ledges merely swivel the egg round. Many casualties are caused, however, as the jostling birds knock the eggs from their amazingly insecure resting-places. The young are brown above and greyish-white below and, when they are hatched, the huge colony becomes even more busy. The air is full of birds taking off to, or coming back from, the search for fish. In September the young are taken by their parents to sea.

The Puffin.—Length, 13 in. Wing, 7 in. The collar and upper parts of this bird are black; the underparts are white; the cheeks are greyish. The beak is an outstanding feature: it is large, very broad, and, like a parrot's, traversed by streaks of bright orange and yellow, with a raised yellow line at the base of the top mandible. In winter, the brilliant colourings disappear. The round, deep-set eye, rimmed with crimson and with a bluish triangle above and a blue bar underneath, gives an amusing expression of serious fixedness.

Habits.—Colonies of these birds are plentiful on the northern coasts of the British Isles, as the birds chiefly inhabit the North Atlantic and the Arctic Seas.

The puffin is an excellent swimmer, and the waters round the site of a colony will be thick with swimming birds, easily distinguished from guillemots and razor-bills by the beak. The bird dives well and swims under water with its wings. The strong beak can catch and hold a struggling fish most efficiently.

It is interesting to note that, although this bird leads a similar life to that of the guillemot and the razor-bill, it is not so highly modified. It stands on its toes (wrongly called the "foot") and not on the whole foot like the guillemot and the razor-bill. It walks well and runs swiftly, a feat impossible with the other birds.

The distinctive, quivering flight is swift and active; when starting from ground level the bird "taxi's off" with open wings like an aeroplane. The note is a deep call, somewhat harsh.

Breeding.—There is one brood. Puffins nest in colonies, the single whitish egg being laid in a hole preferably in soft, springy turf. Old rabbit-burrows may be used, but the puffin usually digs out its own hole, vigorously scratching the soil backwards with its feet. The nestling is covered with long black down with a white patch underneath, and the

parent feeds it on fish. It is said that after about six weeks the parent deserts its young, which remains without food for a few days until hunger forces it to emerge from the burrow and fend for itself.

PLATE 13. SEASIDE BIRDS

The birds on this Plate all belong to the Gull Family (*Laridæ*). The front toes are webbed, the hind toe being free. Most of these birds are equally at home on the land and on the sea. Their flight is powerful, graceful and effortless.

They are omnivorous birds, but feed largely on fish, insects and offal.

The Common Gull.—Length, 17 in. Wing, 14½ in. The back and wings are blue-grey; the head and underparts are snowy white; the primaries are black with two white spots near the tips of the outer two. In winter, the head and the back of the neck are streaked with grey. The bill is yellow; the legs, greenish.

Habits.—In the British Isles the common gull is a resident, a migrant and a bird of passage. It breeds in Scotland and Ireland, but not generally farther south.

The common gull is gregarious at all times, usually living by the shore, but sometimes drifting inland to follow the plough or to paddle about in shallow inland waters. Here, it eats larvæ, earthworms, insects and occasionally grain. On shore, the bird feeds on garbage and catches surface-swimming fish, small crustacea, molluscs and sea-worms. It picks up shellfish and drops them from a height on to a hard surface in order to crack the shell; this performance is repeated until success is achieved. The bird also “dances” over wet sands in order to bring worms to the surface.

The flight is typical of gulls—easy and unhurried, with deliberate wing beats, graceful swoops and sweeps, and periods of drifting long distances with motionless, outstretched wings. The bird has a harsh call and also a long, wailing note.

Breeding.—These birds usually nest in colonies on cliffs, though single pairs are occasionally found inland, nesting on a rocky island or in thick clumps of grass. Three eggs are the normal number; they vary greatly in colour, but are frequently fawn-coloured, marked with black. The nestlings are greyish with brownish streaks. The young are brownish with darker brown markings.

The Common Tern.—Length, 14½ in. Wing, 10½ in. The adult bird has a black cap, blue-grey wings and back, whitish underparts shaded with blue-grey or pink; and a white tail with grey edgings to the streamers.

The legs and beak are red ; the beak is black-tipped. In winter, the underparts are snowy white and the cap is mottled with white.

Habits.—This, the commonest tern in the British Isles, is chiefly a summer visitor, though large numbers are birds of passage. A popular name for the tern is “ sea-swallow,” on account of the long pointed wings and the streaming forked tail.

The bird haunts seashores, but it is most at ease on the wing, when it swoops and flies with grace and strength, every now and then plunging into the sea to capture a fish. When migrating overland, terns catch insects on the wing.

On shore, terns are clumsy walkers. The tips of their long wings are crossed over and usually held well above the tail.

Breeding.—There is one brood. The colonies are variously situated : on sandy shores, on rocky islands, or on coastal sand-dunes. Often no nest is made, but sometimes a large nest is made of straw, weeds, pebbles, marram-grass, or any material conveniently to hand. The eggs vary greatly ; they may be green, or buff, or dark brown ; they may be speckled, smudged or spotted with black, grey or brown. Both eggs and nestlings are preyed on by stoats and, consequently, terns are suspicious of all visitors to the ternery, attacking and often killing small ones and screaming angrily round large ones. The nestlings are fed by the parents on small fish ; they cry insistently for food. They are covered in variously coloured down—grey, deep brown, or sandy-coloured, with black markings.

The Black-headed Gull.—Length, 16 in. Wing, 11 $\frac{3}{4}$ in. In summer this gull is easily known by its dark brown (not actually black) head, and red legs and bill ; otherwise the plumage is similar to that of other gulls. In winter, the head is white marked with brown on the ear coverts and near the eye. The legs and bill are orange-red.

Habits.—This is our commonest gull. It is a resident in all parts of the British Isles, and it is both an inland and a coastal bird. At all times gregarious, it mixes contentedly with various waders on the shore and with rooks and other birds inland.

Inland, the black-headed gull feeds in fields or on sewage farms, seeking a lake or some similar place to roost at evening-time. The bird is undoubtedly useful. It follows the plough, devouring a great number of harmful leather-jackets and wireworms. The bird certainly eats some helpful



FIG. 15. Beak and foot of gull.

insects and a small amount of grain, but it undoubtedly does more good than harm.

On the shore, the gull searches among rubbish for food ; in harbours, it wheels round returning fishing smacks to pick up any outcastings. The bird is not a good fisherman, however, and it is a clumsy diver ; like other gulls it will march up and down wet sand or mud to bring worms to the surface. It is a greedy bird and little in the way of food comes amiss.

The flight is typical of most gulls—deliberate and powerful. The bird sails, wavers and careens about in the air, though migrating flocks fly purposefully and steadily.

The wailing note and harsh call are similar to those of other gulls.

Breeding.—There is one brood. The birds nest in large colonies, usually by lakes, on small sea-shore islands, or high up on the moors. The nest is a mass of sticks, grasses and other materials and may be placed almost anywhere—in thick, outgrowing tufts in water, on dry ground, on a wall or sometimes in a tree. The variously coloured eggs are usually two or three in number—they may be blue, green, fawn, or brown, and covered with markings of grey, black or brown. The downy nestlings vary considerably ; they may be buff, brown or grey, streaked with brown or black.

The Kittiwake.—Length, 16 in. Wing, 12 in. The adult bird has the typical blue-grey and white plumage of most gulls. The tips of the outer primaries are black, appearing in flight as a black triangle. The bill is yellow ; the legs are brownish ; the hind toe is almost non-existent. The immature bird has a dark line round the back of its neck and a band of brown across the wings.

Habits.—This bird is a resident in the British Isles, and is particularly plentiful in Scotland and Ireland. In summer, the bird haunts high cliffs, but in winter it lives entirely on the sea unless driven inland by gales and storms, when lack of food and continual buffeting often spell disaster. Sometimes the beaches are strewn with dead kittiwakes.

The food is chiefly surface-swimming fish and other small sea-creatures that live close to the surface. The kittiwake dives more skilfully than other gulls and can swim under water as it chases its prey.

In March, the birds begin to leave their sea-home and come inshore to nest.

Breeding.—There is one brood. Kittiwakes nest in large colonies on steep cliff-sides, or in caves. The nests built of weed, clay and mud are placed on precipitous ledges, where it would appear that they must crash to the ground. In fact, however, the nests are strong, both birds carefully treading down the clay and mud to form an almost solid foundation. The

two or three eggs are smudged with brown or dark grey on a light background, and the nestlings are covered with greyish-white down. They feed, as do cormorants, by searching for food in their parents' mouths.

The Herring Gull.—Length, 24 in. Wing, 17½ in. This gull can be distinguished from other species by its size—it is the second largest British gull. The distinctive yellow bill has a red stripe near the tip of the lower mandible. The legs are pinkish. The eyes are bright yellow surrounded by crimson.

Habits.—This bird sometimes drifts inland, but it is chiefly a coastal resident.

The herring gull is a useful scavenger. It visits small fishing harbours for garbage ; it flies gracefully after a liner, scanning the sea for ejected offal ; in dockyards and seaside resorts it visits rubbish heaps, or swoops screaming over the waters to pick up any floating carrion.

Like the common gull, this bird drops molluscs from a height to crack the shells and it also prances along the wet sand to entice worms to the surface. Sometimes, it dives for food. In fields it follows the plough where it snaps up insects and their larvæ ; in cultivated fields it eats grain. The herring gull is an egg-thief and robs the nests of other sea-birds, sometimes coming inland for further plunder.

On the shore, herring gulls usually face the wind and rest on one leg with the head sunk into the shoulders.

The flight is typical of all gulls—graceful, apparently effortless and controlled. The cry is a loud scream, sometimes ending in a long mournful wail ; it utters a harsh challenge with wide-open beak and lifted head.

Breeding.—There is one brood. Herring gulls nest in colonies on grassy cliff-tops or on small islands. The untidy nests are built of roots, grasses, seaweed and sometimes sheep's wool ; they are placed by tufts of thick grass, or on a cliff-ledge protected by an overhanging jut. Usually three eggs are laid ; they are brownish or olive with many dark brown markings. The nestling may be covered with greyish brown, or even black, down ; this down later gives way to mottled, greyish-brown plumage. The adult colouring is not attained until after the fourth or fifth year. The young are fed on regurgitated food.

PLATE 14. INSECT-EATING BIRDS—I

The swallow, the house-martin and the swift are generally similar in appearance and habits, but the swallow and the house-martin belong to the *Hirundinidæ Family* and the swift to the *Cypselidæ Family*. These three birds are masters of flight, the swift excelling the other two. The

long wings are powerful, the legs are short, the strong toes are specially adapted for clinging to walls, etc. The food, which consists of flying insects, is caught on the wing.

The wheatear belongs to the Thrush Family (*Turdidæ*); the tree pipit to the Wagtail and Pipit Family (*Motacillidæ*). Pipits have particularly long inner secondaries; in colouring they are generally sober.

The cuckoo (*Cuculidæ*) is one of a large family of tree-dwellers. The birds of this tribe are yoke-toed, having two toes in front and two behind.

The Tree Pipit.—Length, 6 in. Wing, $3\frac{1}{2}$ in. The general plumage of this bird is light brown streaked with dark brown on the upper parts, breast and sides. The underparts shade off to dull white. Both sexes are alike.

Habits.—This is a fairly common summer visitor, arriving in England during April. It haunts parkland, or the slopes of hills where there is open woodland.

The tree pipit is an attractive little bird, with cheery energetic habits. It sings its lark-like melody from some favourite perch and also when on the wing. Characteristically, the bird flutters up from a bush bubbling happily with song, soon descending with outspread tail and wings, still singing, until it reaches the perch again. The anxious piping alarm note is repeated continually when intruders approach the nest.

The food consists of insects, though sometimes seeds may be eaten.

Breeding.—There is one brood. The nest is placed on the ground, frequently shaded by overhanging ferns or grasses. The four to six eggs vary greatly in colour; they may be almost white with a few dark markings, or dark reddish with thick spots and smudges of purple. The cuckoo often lays its egg in the nest of a tree pipit.

The Swallow.—Length, $7\frac{1}{4}$ in. Wing, 5 in. The upper parts of the plumage are bright glossy blue with darker tail and wings. The forehead and throat are bright chestnut; the underparts are buff.

Habits.—This well-known migrant begins to arrive in England about the middle of March, announcing its advent by a perpetual twittering song. On arrival, the birds usually haunt stretches of water where there are likely to be plenty of insects even so early in the year. Later, when insects become plentiful all over the countryside, they seek suitable nesting-places.

The food is almost entirely insect, the prey being caught on the wing as the birds swoop agilely about. Blow-flies, crane-flies and aphides of all sorts are eaten in great quantities, and the useful swallow should certainly be encouraged.

Swallows are not at home on the land and, in general, alight only to

collect mud for nest-building. The short legs are not adapted to walking, though the birds perch well.

In autumn, before the mass migration takes place, the birds return to the water haunts they occupied on their arrival.

Breeding.—There are one, two or three broods. The usual nesting-place is on a beam inside a building, where the nest built of mud mixed with straw and hair is firmly fixed. Swallows often return annually to the same nest, repairing it by adding fresh mud. Four to six white eggs, speckled with light brown, are laid in May. Late broods may be unfledged by October, and in this case they are left to die when their parents become seized with the desire to migrate.

The Swift.—Length, 7 in. Wing, $6\frac{3}{4}$ in. This bird is blackish-brown in colour, with a white patch on the chin. The legs are very short and feathered to the toes.

Habits.—In April, this summer migrant announces its arrival by high screams as it rushes rapidly through the air. 'The swift is the most aerial of all our birds, the very short legs being quite unfitted for walking—indeed, the bird cannot walk. The strong toes, however, enable it to cling with ease to rough surfaces.

Swifts are gregarious and small companies gather together, sporting tirelessly in the air, or screaming wildly as they charge after winged insects. The height at which they fly depends largely upon the height of flying insects, and in this way has relation to the weather.

In the evening, swifts rise high into the air, screaming continually until they are invisible and only the sound of their cries is heard. It has been supposed that they spend their night on the wing, but this theory appears improbable and is not supported by available evidence. Some birds at any rate have been found to re-enter the nesting-places when practically dark. In the breeding-season some birds not engaged in incubation roost under eaves of houses or in other cavities or shelters near the nests, and probably all do so.

Like the swallow, the swift is a valuable friend to farmer and gardener on account of the numerous winged pests it devours every day.

The autumn migration usually begins about July and continues during August, though stray swifts may be seen later in the year.

Breeding.—There is one brood. The nest is usually built on the rafters of a house. The materials used are straw, grasses and various litter stuck together with saliva, which soon hardens to make a secure cup. Two or three long, white eggs are laid. The young are similar to their parents, except that the patch on the throat is whiter.

The House-Martin.—Length, $5\frac{1}{2}$ in. Wing, $4\frac{3}{4}$ in. The plumage of

the adult bird is steely blue above with white cheeks and underparts. There is a conspicuous white patch on the rump; the wings are brownish and the blue tail is forked, but much shorter than in the swallow. The short legs and toes are covered with white down.

Habits.—This summer migrant arrives later than the swallows from which it can easily be distinguished by the white patch above the tail.

The flight and habits are mainly similar to those of the swallow. On arrival, it haunts watery districts for the abundance of insects which, like the swallow, it catches on the wing.

The house-martin descends to the ground more frequently than the swallow and it may even walk a few steps. The note is a pleasant, cheerful warble, and, unlike most birds, the house-martin continues its warbling when close to its nest or even when sitting. It is a gregarious bird at all seasons.

Breeding.—There are two or three broods. The half-cup-shaped mud nest is preferably plastered to the wall of a dwelling-house under the eaves, often several close together, for martins are very sociable. Conversation is amiably carried on during the building; squabbles with interfering sparrows are frequent. Four or five white eggs are laid, the first brood usually in July.

The Cuckoo.—Length, 13 in. Wing, 8½ in. The head and upper parts are slate coloured; the wings are brownish, the tail is blackish with white tips and bars to the outer feathers. The underparts are white, barred with dark brown. The beak is slightly hooked and the legs are short and feathered low. The young birds have brown barred upper parts with many white-tipped feathers. The underparts are buffish, barred with brown.

Habits.—This well-known bird, familiar chiefly for its call, arrives in England in April. In flight, it appears as a long-tailed, slim bird, the barred underparts giving a somewhat hawk-like appearance. The flight is usually direct and swift; the movements are rather clumsy.

The cuckoo is a useful bird as it devours harmful hairy caterpillars (such as those of the tiger-moth) which are shunned by other birds on account of their hairs. These form in the cuckoo a thick lining in the gizzard, and small pellets of matted hair are periodically regurgitated. Beetles, worms and some seeds are also eaten. The cuckoo is greedy and will do much good during a plague of harmful larvæ; though it should be remembered that for each cuckoo hatched, a nestful of useful insect-eating birds perishes.

Besides the well-known “cuc-koo,” this bird has a rippling cry, often used by the female in answer to the male. There are far more male

cuckoos than female; it is said that the female has first one mate and then another, attaching herself to none. This lack of settling down may account in part for the breeding habits, since with other species the male helps to establish the settled home. The bird generally returns year after year to the same haunt.

Breeding.—Much controversy has raged concerning the habits of the cuckoo in the matter of breeding, but careful study has established the chief facts. Before laying an egg, the cuckoo removes one of the fosterer's eggs in her bill, and after depositing her own flies off with the stolen egg, which is either swallowed whole or broken up in alighting. Investigations show that the cuckoo lays her egg in the usual way while sitting on the chosen nest, or, where the entrance is too small, raises herself with outspread wings and tail against the opening and ejects her egg into the nest, though not invariably successfully.

Probably twelve or fewer eggs are laid by each bird, and usually each is deposited in a different nest. The chosen nest may be that of a meadow pipit, tree pipit, pied wagtail, robin, wheatear, or one of the warblers.

The eggs, which are small, vary in colour considerably; sometimes they closely resemble the eggs of the host, though this is probably accidental. The nestling cuckoo is at first naked and blind. It rapidly disposes of the other inhabitants of the nest, be they eggs or nestlings, by ejecting them over the side. The hollowed back of the young cuckoo is extremely sensitive, and when in the crowded nest one of the young birds falls on to this back, the cuckoo at once stiffens and edges its way up the side of the nest until it can push the unfortunate creature over. This procedure is repeated until usually the cuckoo remains as the sole occupant—a fortunate arrangement when we consider its tremendous appetite. The foster-parents apparently do not resent this conduct; they immediately spend all their energy in feeding their rapidly growing and voracious visitor, which clamours for food continuously. In the case of small birds, the cuckoo soon out-grows them and they must needs stand on its back to present it with food. The young bird is ill-tempered and will peck a human hand, fluffing out its feathers and hissing angrily.

The Wheatear.—Length, $5\frac{3}{4}$ in. Wing, $6\frac{1}{2}$ in. The male bird has a bluish-grey back. The forehead, eye-stripe, rump and lower part of the tail are white. The ear-coverts, cheeks and tip of the tail are black. The wings are blackish; the underparts are sandy. The female is sandy brown above and lighter below; like her mate she has the distinctive white rump and black-tipped tail.

Habits.—This bird is one of the first summer visitors to reach us,

arriving early in March. The favourite haunts are moorlands, heaths, downland and hills or other high rocky regions.

The wheatear is a restless bird, constantly on the move, flitting from one boulder to the next, chirruping repeatedly. It bobs up and down, flips its tail, and twitters as it flits from pillar to post, frequently darting up into the air, turning and twisting as it catches an insect, or sings a little snatch of song.

In flight, the white rump is conspicuous; it is from this that the wheatear or white-ear gets its name, "ear" being derived from "ers" meaning "rump." The bird eats worms, insects of all kinds—many of which are caught on the wing—and the small helices (snails) which are abundant in the short turf of downland or cliff tops.

Breeding.—There is usually one, but occasionally two, broods. The nest is loosely built of grass, rabbit's fur, wool, hair, feathers and moss, and is placed in a rabbit's hole or a cleft in a rock. Four to six greenish-blue eggs are laid in April or early in May.

PLATE 15. INSECT-EATING BIRDS—II

The chiff-chaff, the garden warbler and the blackcap belong to the Warbler Family (*Sylviidæ*). (See Plate 3.)

The whinchat is a member of the Thrush Family (*Turdidæ*).

The spotted flycatcher (Family *Muscicapidæ*) belongs to a group the members of which are closely allied to the swallow, and their habits are somewhat similar. They both catch insects on the wing, the flycatchers "hunting" from a suitable perch.

The yellow wagtail belongs to the Wagtail and Pipit Family (*Motacillidæ*). Wagtails are graceful birds both on the ground and in the air. They generally inhabit watery districts, and are commonly given the name "dish-washers." They are most useful, since their food consists mainly of insects and sometimes the seeds of various weeds.

The Spotted Flycatcher.—Length, $5\frac{3}{4}$ in. Wing, $3\frac{1}{2}$ in. The upper parts of the plumage are grey-brown with dark brown streaks on the top of the head. The underparts are whitish with dark spots on the breast. On either side of the base of the bill are numerous hair-like projections which serve to prevent insects from getting on to the bill itself.

Habits.—This bird is a summer visitor, usually arriving some time in May. It haunts the outskirts of woods, large gardens, or the trees growing beside a stream. The spotted flycatcher is expert at catching flies on the wing. It rests upright on some favourite perch from which it darts out repeatedly to snap up winged insects, few of which escape its bright

eye, and very few of which it fails to capture. In addition to small flies, butterflies, beetles and moths may be eaten.

The spotted flycatcher is shy and silent and its habit of quietly watching for insects is not likely to attract attention. It should, however, be encouraged whenever possible since it is a most useful bird. The song is soft and low ; the call is also soft.

Breeding.—There is usually one brood. The nest is loosely made of grasses, leaves, moss and hair, and is placed for preference close to a building—on a window-ledge, for instance. Old nests of other birds are often used, a new lining of hair being added. Four or five dull white eggs spotted with orange-brown or red are laid about the beginning of June. The young birds are more spotted than their parents.

The Chiff-Chaff.—Length, $4\frac{1}{2}$ in. Wing, $2\frac{1}{2}$ in. The upper parts of the plumage are greenish-brown ; the underparts are pale. There is a conspicuous whitish eye-stripe.

Habits.—This summer visitor arrives in March. It haunts woodlands where it sings busily from some perch a simple, reiterated song. The bird has a short, whistling note when alarmed or excited.

The food consists of insects, small larvæ and spiders, which are pecked up from the bark of trees. Flies are smartly caught on the wing.

The chiff-chaff is jealous of its nesting-site and will attack much larger birds that attempt to invade the premises.

Breeding.—There is usually one brood. The domed nest of leaves, moss and grass is placed close to the ground or sometimes in a hedge or bush. Five to seven white eggs, sparsely dotted with brown or purple, are laid early in May. The young have browner upper parts and yellower underparts than their parents.

The Whinchat or Winchat.—Length, 5 in. Wing, 3 in. The general colour of the plumage is yellow-brown with very dark streaks on the back ; the cheeks are black surrounded by a white line, and there is white on the brown wings and tail. The underparts are sandy, shading to dull white. The female is paler in colour than the male and the upper parts are darker.

Habits.—This summer visitor arrives late in April. It haunts heaths, commons, bushy lowlands and marshes, where it may be distinguished from the hen stonechat by the white eye-stripe and the white patches on the wing.

The whinchat often perches on the highest twig of a gorse bush constantly repeating an insistent, metallic call, and fanning out the tail for balancing. Now and again it darts after a passing fly, or takes a short flight, singing as it flies. The sight is keen and few flying or crawling insects are missed. Beetles and the small flies that hover over the long

meadow grasses are favourite food ; at twilight the whinchat catches moths. In migration, it travels in small companies, sometimes mixing with wagtails and wheatears.

Breeding.—There is usually only one brood. The nest is generally placed on the ground and is well hidden at the foot of a bush or by a tuft of thick grass. Five or six greenish-blue eggs, lightly dotted with brick-red, are laid in May. The young birds are redder and lighter in colour than their parents.

The Yellow Wagtail.—Length, $6\frac{1}{2}$ in. Wing, $3\frac{1}{4}$ in. The upper parts of the plumage are olive-green ; the wings are dark brown barred with white ; the two outer feathers of the tail are white. The underparts and the conspicuous eye-stripe are sulphur-yellow. The female is browner than the male ; the eye-stripe and wing-bars are buff and the underparts are paler.

Habits.—This summer migrant appears in March and April. It frequents damp meadows, open country, commons, marshes or cultivated fields, the brilliant plumage of the male being most conspicuous.

The wagtails are nimble little birds, darting quickly about hedgerows or among the long grasses in search of insect food ; they look like bright flowers as they run amongst grazing cattle, pecking up the insects disturbed by their feet. The long, white-edged tail is perpetually flipped and waved ; the head wags gently as the bird walks with quick short steps. Yellow wagtails follow the ploughman, continually on the look out for larvæ. They devour a certain snail which is a host of the liver-fluke that attacks sheep, and for this service alone the bird deserves protection.

In general, this is a silent bird, though flocks of roosting yellow wagtails may twitter softly among the reed-beds.

Breeding.—There are two broods. The nest, built of grass, moss, feathers, hair and roots, is usually placed on the ground screened by a tuft of thick grass. Four to six eggs are laid in April ; they vary considerably in colour but are often whitish with grey or brownish speckles. The birds fill their beaks with flies for their young, adding more to the store without dropping those already trapped.

The Blackcap.—Length, $5\frac{3}{4}$ in. Wing, $2\frac{3}{4}$ in. The head and back of the neck are black ; the upper parts brownish ; the tail and wings are darker with grey edgings. The underparts are pale grey, almost white on the chin and by the legs. The female is darker above and more buff-coloured below. Her crown is reddish-brown.

Habits.—This warbler is a common summer resident, frequenting woods, plantations, and large gardens or parks. It is rather shy in its habits, singing its beautiful song from dense undergrowth as well as from

a tree-top. The song is so tuneful that in some districts the blackcap is known as the "northern nightingale." The male bird often becomes most excited when singing; the eyes glisten and the black feathers of the crown are raised into a crest.

The food consists chiefly of insects, though fruit is favoured, particularly the ripe berries of ivy.

Breeding.—There is one brood. The nest is made of dry grasses and roots, with hair and fine grasses as a lining, and is usually built in a low bush. Four or five variously coloured eggs are laid; they may be yellowish or reddish and are mottled, shaded or blotched with reddish-brown.

The Garden Warbler.—Length, $5\frac{1}{2}$ in. Wing, 3 in. The upper parts of the plumage are brownish; the underparts are white, shading to buff on the throat and sides.

Habits.—This is a common, though inconspicuous, summer visitor. It haunts the woodlands and thickets, and is a shy, restless bird, constantly hopping about from twig to twig in search of insects which form its staple diet. Flies are caught on the wing. Berries are also favoured. The garden warbler joins other birds in raids on orchards or gardens.

The song is particularly tuneful—a continued, liquid warble, sometimes reminiscent of that of the nightingale. Often, the song is all that can be known of the garden warbler, for it hides itself in thick undergrowth, and its sober plumage is not likely to attract attention.

Breeding.—There is one brood. The frail nest is built of grasses twisted together and lined with hair and soft grass. It is usually built in a low bush near a wood. Four or five yellowish eggs, mottled with greenish-grey or brownish-red, are laid late in May.

PLATE 16. INSECT-EATING BIRDS—III

The birds on this Plate, though belonging to various families, are all insect-eaters possessing the typical slim, pointed beak of such birds.

The stonechat belongs to the Thrush Family (*Turdidæ*). (See Plate 2.)

The pied wagtail, the grey wagtail and the meadow pipit belong to the Wagtail and Pipit Family (*Motacillidæ*). The hind claw of these birds is frequently elongated, as is the case with the larks (*Alaudidæ* Family). Both pipits and larks are soberly clad; the wagtails are more handsomely coloured.

The wren, "the smallest bird in England," (*Troglodytidæ* Family) is the British representative of a widely-spread group. Our own bird is brown in colouring, and all wrens are usually dull-coloured. The nest of nearly all the wrens is dome-shaped and soft.

The Stonechat.—Length, 5 in. Wing, $2\frac{1}{2}$ in. The head, throat and back are black, with brown on some of the feathers ; the wings and tail are brown. There is a white patch at the side of the head and on the wings. The underparts are chestnut-red shading to buff. The female is browner and duller than the male and the white patches are less definite.

Habits.—The stonechat is both a resident and a migrant. It haunts gorse-clad commons and waste land, rocky foot-hills, and the lower regions of moorlands.

The male bird is easily seen because he perches on the topmost twig of a gorse or other bush, his tail flicking continuously and his rotund little body bobbing up and down. The curious alarm note, sounding like pebbles struck together, has given this bird its name. The stonechat has also an indeterminate song which is sung on the wing or from the usual perch.

The food is chiefly insects, though seeds may also be eaten. Small worms, larvæ, and spiders are taken, and it is said that the little lizards that abound in rocky districts are sometimes captured.

Breeding.—There are two broods. The well-hidden nest is placed on or near the ground and is built of grass, moss and small roots. Hair and a few feathers make the lining. The hen has a hidden pathway through the long grasses along which she can travel undetected to and from her nest. There are five or six eggs, greeny-blue in colour with a faint circle of reddish spots at the larger end. The young are spotted and streaked ; the tail feathers have wide, fawn-coloured margins. They are some time before gaining their full white collars.

The Wren.—Length, $3\frac{1}{2}$ in. Wing, 2 in. This tiny bird is reddish-brown above and lighter underneath. It is barred all over with darker brown and dark grey. There is a pale eye-stripe and the chin is whitish. The tail is very short.

Habits.—This mouse-like bird haunts gardens, uplands, farmyards, woods, and reed-beds. It creeps and darts about the hedgerows seeking for food, all but hidden from view, and is ceaselessly active searching for hidden insects. Chiefly, only small insects are eaten, but in winter some seeds and large larvæ will be pecked up. At night-time several wrens roost together.

The bird has a strong, sweet song which it delivers with its whole body quivering with energy. It seems to have a passion for building nests, and many are built which are never used—even if they are wholly completed.

Breeding.—There are two broods. The round, domed nest is usually placed in a hole or some well-sheltered spot. Dead leaves, moss, grass, and other accessible materials are used and the lining is usually of feathers

or hair. Five to eight, or even more, whitish or lightly speckled eggs are laid in April. The young are similar to their parents but less definitely barred.

The Meadow Pipit.—Length, $5\frac{1}{2}$ in. Wing, $3\frac{1}{4}$ in. The upper parts of the plumage are olive-brown with darker markings; the underparts are whitish, lightly streaked with dark brown; the buffish breast is spotted. There is a conspicuous light eye-stripe, and the hind toe has a long claw.

Habits.—This bird is both a resident and an abundant summer visitor. Favourite haunts are moorlands, downs, heaths and other wide open spaces where many may be seen fluttering above the heath, whistling their short song as they fly. Winter haunts are sheepfolds, marshes, or lake-sides, where small flocks live among the reeds.

On the ground, meadow pipits run and walk with jerky, spasmodic movements, similar to, but less graceful, than those of the wagtail. The flight is jerky and short.

The food consists of insects and seeds of various kinds.

Breeding.—There are two broods. The well-hidden, cup-like nest is built on the ground usually in or beside a clump of grass. Five or six eggs, dark brownish-red and speckled, are laid in April, the second brood being laid about August. The meadow pipit is constantly victimised by the cuckoo.

The Grey Wagtail.—Length, $7\frac{1}{2}$ in. Wing, $3\frac{3}{4}$ in. The head and back of this bird are slate-coloured, the underparts are bright yellow, the rump is greenish-yellow. The cheeks are grey with white streaks below and above; the chin and throat are black. There are white feathers in the tail and pale margins to some of the brown-black wing feathers. The female has little or no black on the throat; the head and back are shaded with green.

Habits.—The grey wagtail is even more fond of the water than the pied, and running water is especially favoured. When walking along by a stream, it dips its head with every step; it runs nimbly over stones half-submerged by water, every now and then leaping up to catch a hovering gnat or fly, and quirking its tail as it lands again.

The chief food is insects, but the grey wagtail also eats river-limpets and small crustacea. It perches on overhanging branches, darting down to catch the flies which dance over the water.

As winter cold causes inland waters to freeze, the bird moves towards the coast, and in many cases migration takes place. The flight is undulating; the call is soft.

Breeding.—There are two broods. The nesting-place is usually in a

hole in a bank or rock close to running water. Grasses and small roots form the body of the nest which is lined with hair. Four to six greyish eggs, marked with creamy-brown, are laid in April.

The Skylark.—Length, $7\frac{1}{2}$ in. Wing, $4\frac{1}{2}$ in. The upper parts of the plumage are light brown, streaked with darker brown. The underparts are pale; the darker breast is spotted with brown. The small crest on the head is usually raised when the bird is on the ground. There is a pale eye-stripe. Both sexes are similar.

Habits.—The skylark is one of our best-loved birds on account of its wonderful outpouring of song. It is a widely-distributed resident, but many birds migrate for the winter months, returning for the nesting-season; others stay here for a short time as birds of passage. Open fields, moors, marshes, or shores are the favourite haunts. In winter, skylarks are gregarious, flocking together for feeding. They roost on the ground and when approached, crouch close and then fly off one by one, each uttering a soft call. The food consists of seeds of all sorts; in summer insects are eaten. The bright green of young grass and young corn attract the skylark, but generally it does little harm.

The song is a continuous outpouring of liquid notes and trills, remarkable for its volume and continuity. The skylark soars from the ground with fluttering wings, singing all the time and rising higher and higher until lost from view, though the joyous song is still heard. When descending, the song suddenly stops; the bird plunges quickly to the ground and alights a few feet from the nest.

Breeding.—There are usually two broods. The nesting-place in the grass is hidden; the birds alight a few feet away, then run through a hidden pathway to the grass-built nest. Three to five eggs, closely spotted with brown, are laid in April. The spots and streaks on the breast of the young are more pronounced than those on the adult birds.

The Pied Wagtail.—Length, $7\frac{1}{2}$ in. Wing, $3\frac{1}{2}$ in. The crown, the nape of the neck, the chest and the back are glossy black; the forehead, cheeks and underparts are white. The wings and tail are black-and-white. The female is greyer in colouring and has a shorter tail.

Habits.—The pied wagtail is both a resident and a summer migrant. It lives near shallows and water of any kind, and is frequently seen near river beds or by ponds, or, in rainy weather, running swiftly about among the puddles in roads. It may also haunt farmyards, dashing between the legs of grazing cattle to catch the insects disturbed from the grass. The birds may often be seen following the plough in their search for larvæ.

The pied wagtail is attractive to watch; it darts nimbly here and there, holding its long tail horizontally, and flirting it continuously,

frequently leaping into the air after gnats. In spring, flocks of pied wagtails feed in the fields with meadow pipits, and at night both groups will roost together in reed-beds.

The flight-call is shrill.

Breeding.—There are two or three broods. The nest is placed almost anywhere so long as there is plenty of protection and shelter. Grass, moss and roots are well and firmly woven together, and the nest is lined with feathers or hair or wool. There are four or five whitish eggs speckled with ashy-grey spots. The tails of the young nestlings are short.



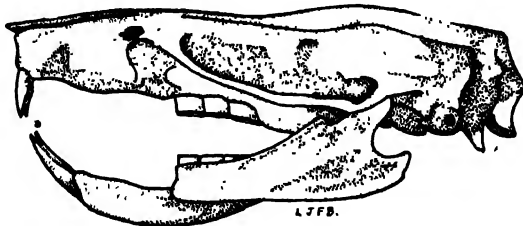
FIG. 16. The male wagtail displaying before the female (redrawn from drawing by G. E. Lodge, 1929).

LAND ANIMALS

PLATE 17. GNAWING ANIMALS—I°

Introduction.—Mammals and birds are the two highest groups of animals. Both have found in family life the solution of the problem of caring for the young, but in mammals the young have the additional security of being developed to a more or less advanced stage in the mother's body, that is, the egg is not laid, but retained in the uterus, receiving nourishment through the blood stream by means of an organ of attachment and nutrition called the placenta. This also acts as a sieve holding back substances which might be injurious to the young animal (*embryo* or *fœtus*). After birth the young are suckled on milk. This has a great advantage over the method of parent birds, which spend nearly all their waking-hours in obtaining food for their offspring, in itself a limitation of the possibilities of life for mature birds. In the physical and physiological habits of mammals, we can see, therefore, the foundation for the development of the family and of social life which has been brought to such complexity in man.

Mammals are covered with hair. This covering, and feathers, are the two warmest skin coverings. They help to retain the heat of the body, and so play their part in regulating and maintaining the temperature at a constant high level, irrespective of the temperature of the surroundings. This high temperature is one feature that enables mammals and birds, the so-called "warm-blooded" animals, to be so much more active throughout the year than the "cold-blooded" fish, amphibia and reptiles. Though a number of the smaller British mammals are said to hibernate, this is not the complete, continuous inertia exhibited by frogs or snails, nor is it accompanied by marked physiological changes such as accompany true hibernation.



• FIG. 17. Skull of rat.

In the development of their senses most mammals and birds show a higher level of consciousness, or, at any rate, of awareness, than the "cold-blooded" lower animals.

All the animals shown on Plate 17 are *Rodents* or *Gnawers*. With a few exceptions, such as the beaver and American cavy, rodents are all quite small animals, not exceeding 1 ft. or so in height, or 2 ft. in length, many of them being only a few inches long. They are for the most part herbivorous, many of them obtaining much of their nourishment from the bark of trees, wood, nuts and other hard seeds, though most of them will eat eggs or young shoots. Their teeth are particularly suited to their diet; the front teeth or incisors are chisel-like, with a bevelled edge; the cheek teeth or molars have a broad, flat, ridged chewing surface. There is a gap between the two sets, since there are no canine teeth. The teeth grow continuously from the roots so that, as they are worn down with hard usage, they still retain their full length. Nearly all rodents have large eyes, placed well to the top of the head, with a wide range of vision. The ears are mobile. Sight and hearing are both very keen.

The Red Squirrel.—Length, 8 in. This is the native British squirrel, inquisitive, alternately timorous and bold, quietly observant or chattering and scolding. It lives entirely in trees, only coming to the ground where there are no trees sufficiently near together for it to pass from one to another by the boughs. It may, however, occasionally be seen feeding on the ground; it comes down to collect beech nuts, pine kernels, and so on, and sometimes its well-known hoards are in holes in the ground or at the foot of trees. Incidentally, there is considerable doubt whether these hoards are really re-visited, except by accident. The squirrel seems to have the instinct to collect and hide nuts, but appears to forget about them. It makes a nest or drey in a tree—pine-trees are much favoured. The drey is an untidy, twiggy pile, about the size of a rook's nest, but rounder and of more varied materials, including bark and leaves. A larger nursery drey is made in which the young are born and reared. In the winter, the red squirrel retires to a drey and becomes dormant, but in spells of warm or sunny weather, especially about February, it may be seen wandering forth to have a good meal and a little exercise.

The squirrel has a marvellous power of leaping from bough to bough. Its hind legs are longer than the front and are used as spring-boards. Its slender feet are roughened with hairs underneath, its claws long and sharp; there are four toes with a rudimentary first digit or thumb on the front feet, and five hind toes. It is thus able to cling to boughs or run rapidly up the trunk of a tree. It is extremely alert and quick. The bushy tail is as long as the body, which is white below and reddish-brown elsewhere.

The most familiar view of the red squirrel is sitting up on its haunches holding a nut between its short forepaws. The tail is curved over the back and then away, probably helping it to balance on the boughs, both when sitting still or leaping actively along. It does little, if any, damage to crops, being perhaps almost our only native rodent which does not.

The Grey Squirrel.—Length, 10 in. Authorities have come to the conclusion that there is nothing good to be said for the imported Canadian or American grey squirrel, charming and attractive as it seems, boldly making friends with human beings in the London parks and other places to which it has spread. It has, indeed, spread far too widely and multiplied too rapidly, so that there is danger of it becoming a serious pest of crops, to say nothing of its attacks on pheasants' eggs and young game birds. There is nothing shy about the grey squirrel. It is clamorous and pugnacious, and is gradually ousting the red squirrel from our woods, both by seizing upon the same food and, so game-keepers say, by actually attacking and killing the red species. The grey squirrel should be regarded as a tree rat, with many of the rat's objectionable features; yet having said all this, one regrets the impending fate of this likeable, impudent urchin.

The Hare.—Length, 20 in. The hare is a creature of the open country, pasture and furrow and stubble fields. It has no lair or nest, but sleeps and brings up its young in the open, cowering in a "form" or slight depression scraped out of the soil. The light, sandy colour blends with sun-drenched fields or yellow stubble, the white under-surface counter-acting any shadow. Sight, smell and hearing are keen, the eyes large and placed high, the ears longer than those of a rabbit, the nose continually twitching.

Hares are solitary, except when young, when the families remain feeding together for some time after the mother leaves them. Three or four young are born at once and they remain with the doe for about a month. They are much further developed and less helpless than young rabbits and have their eyes open when born.

The Rabbit.—Length, about 16 in. Rabbits are essentially gregarious and social. They excavate a complicated underground system of burrows, called a warren, generally in light, dry soil. They remain underground for a good part of the day, coming out in great numbers to feed at dusk and in the early morning; nevertheless they may be seen sitting at or near the mouths of the burrows at any time. They are active in winter. The warren always has several bolt holes or emergency exits, particularly useful when ferrets or stoats go hunting in the burrows.

Rabbits are very prolific and constitute a serious menace to crops, both in field and garden. Each mature doe will produce in a year several

litters of about eight young over a period of three or four years. A nest is made either in a blind tunnel of the warren or in a straight shaft dug underground by the doe, some distance away from the community. She plucks out fur to make a comfortable bed for the young, which are naked pink objects two to three inches long, quite helpless and blind. The mother feeds them in the morning, then covers them up warmly and leaves them, after hiding the entrance to the hole most carefully with tussocks of grass—not so successfully, however, that they cannot frequently be nosed out and eaten by various enemies, including dogs and badgers, which dig down to where the young lie hidden.

There is no doubt that rabbits communicate with one another by stamping with their hind feet, and it may be that they have some kind of recognisable code. They also give an alarm signal by tilting the conspicuous white scut or short tail.

In colour, rabbits are darker than hares, being brownish-grey, with light underparts. Occasionally a black or white rabbit will appear as a "sport." The hind legs in both are much longer than the front, and the hind foot is long. When either a hare or rabbit is at rest the whole of the hind foot lies on the ground, and it can be used quickly to get a good spring off as the animal moves. The feet are hairy underneath, the rough hairs giving a grip of the ground.

Both rabbits and hares have a curious arrangement of the upper incisor teeth. There are four, a front pair and two behind them, while in the lower jaw there are only two. It sometimes happens that a rabbit breaks a tooth. The opposite tooth, having nothing to bite on, is not worn down, and since the teeth continue growing from the roots, the tooth may grow into the opposite jaw, preventing the animal from feeding. It is said that there have been cases of death by starvation following such an accident.

PLATE 18. GNAWING ANIMALS—II

The Dormouse.—Length, about $5\frac{1}{2}$ in. from the tip of the nose to the tail. This mammal is not strictly speaking a mouse, and the difference can be noted at once, for it has a roundish head and large, dark eyes, whereas mice have long, pointed snouts and comparatively small eyes. The tail is bushy instead of almost hairless as in mice. The ears are short, the body is plump and the thick coat is of a bright yellowish-buff colour, with white underparts. The whiskers are long.

The name is due to the animal's habit of sleeping, both in the daytime and through the winter from October to April. If the dormouse wakes

in the winter in mild weather, there is always a danger that it will succumb to sudden returning cold or frost. It makes a well-hidden winter nest, to which it retires after feeding heartily for some time beforehand, so that it becomes fat. This fat probably keeps it warm as well as acting as a store of food.

In the summer the dormouse makes a nest about the size of a cricket ball, using fine twigs and strips of bark—especially honeysuckle—and lining it with leaves. Hazel bushes are frequently chosen for the nest, which is placed 1–2 ft. above the ground. Here it sleeps in the daytime, wandering out at night in search of nuts, insects, grubs, worms and other small creatures on which it feeds. The dormouse can climb extremely well.

The Wood Mouse or Long-tailed Field Mouse.—This true mouse is the largest and probably the commonest British species of mouse. Larger than the house mouse, with longer tail and legs, it measures about 8 in. in all. It has light yellowish-brown fur, less drab than that of the house mouse. (A larger variety, known as de Winton's mouse, is also common.)

Its habitations are various, and it frequently invades houses in the country, especially in the autumn. It is found in hedges, banks, pasture fields and cornfields, and in rickyards, as well as in thatched roofs and haystacks. It is a great climber and will often take possession of old nests of birds or of dormice. The presence of wood mice can often be detected by the scattered remnants of hips and other berries, either on the ground or in the nest; they also feed on corn and all kinds of seeds. They attack young crops in gardens, and have a special partiality for pea seedlings and pea-pods.

Note the very slender, almost naked, prehensile "hands" and feet, which enable them to climb anywhere in search of food.

The Harvest Mouse.—Length in all, about 5 in. This is the smallest of our mice. It is greyish-brown, with reddish-brown hindquarters. The long tail can be twisted round a slender support, such as a corn-stalk, to help it in climbing. It feeds chiefly on insects, but eats seeds also, and is often found in corn, oat and bean stacks, to which it is probably carted, but its real home is the cornfield, where it builds a spherical nest amongst corn-stalks which it binds together. The nest is built while the corn is young and carried upwards as it grows. There is no opening, and the mother squeezes through the inter-twined blades of grass or wheat.

The harvest mouse is a great climber and is said always to run upwards to escape danger. It runs up the corn-stalks and bites off the ears so that they fall to the ground, where it can then nibble the seeds at leisure. It is not common in the north of England or in Scotland, and is not found at all in Ireland. It needs water.

The House Mouse.—This mouse is slightly smaller than the wood mouse, being usually just under 7 in. from the nose to the tip of the tail. It has a long pointed snout; short, silky, brownish-grey hair; a long flexible tail, which is thicker than that of the wood mouse, and rather smaller black eyes. Various shades, both darker and lighter than the normal hair-colouring, occur. It is a wonderful climber, and its chisel-like teeth can nibble through wood and even much harder materials, as it cuts galleries or opens up holes wherever it wants to go. Though primarily a grain-feeder, it will eat practically anything, and any remains of man's food left lying about are its treasure trove.

The house mouse may produce four or five litters of five to twelve young in a year, and these are mature and ready to breed in six weeks. Though these mice chiefly inhabit buildings, they will also accommodate themselves in haystacks and cornricks.

The Brown Rat.—Under favourable circumstances brown rats, which are the common rats, grow to a great size, but the average is about 15 in. from the nose to the tip of the tail. Their relationship to mice is clear, for they have a similar shape of head, body and tail, a long snout, bright beady eyes, short rounded ears, sleek short brownish-grey hair, and a long, scaly tail, only sparsely covered with short hairs. The feet, ears and tail are of a pinkish flesh-colour. The gnawing-teeth are extraordinarily powerful—rats have been known to gnaw through lead pipes. They are agile, intelligent, cunning and ingenious, and very wary. They can climb and swim excellently, and often make their homes in the banks of ditches and drains, as well as in all kinds of buildings such as barns and warehouses and the holds of ships. No food stores are safe from them and they are estimated to effect many millions of pounds' worth of damage in Britain every year. Besides attacking all kinds of food stores, they steal eggs from nests, and kill and eat young poultry, game birds and fish. They are also a great danger as carriers of disease; in particular their fleas are the carriers of bubonic plague.

The brown rat is even more prolific than domestic mice, having as many litters but larger numbers of young. Rat catchers only succeed in keeping the numbers more or less constant, not in reducing them. Weasels, cats and barn owls are their natural enemies.

The Water Vole.—This is neither a rat nor a mouse, though it is often called the water rat, and the various voles are called short-tailed mice. They are, however, very different from rats and mice. They are more like dormice, having a rounder head, larger eyes, broader face and blunter snout than rats and mice. The fur is also longer, and thicker. The water vole is 12 in. long from the nose to the tip of the tail, with dark greyish-

brown fur, looking almost black when it is seen in the water or just emerging from it. The underparts are white. It lives, and produces two, or three litters a year, in burrows in the banks of streams ; it feeds mainly on reeds, water-plants, fallen leaves, or the branches of trees which hang over the water. It swims and dives, and can remain under water for some time.

PLATE 19. AMPHIBIOUS ANIMALS

Introduction.—Amphibians are the lowest group of vertebrates which breathe atmospheric oxygen by means of lungs, and spend part of their life on land. The root of the word amphibian means *both*, indicating that the life history comprises both land-dwelling and water-dwelling stages, for they first breathe oxygen dissolved in water, and later free, atmospheric oxygen. In the first stage the animals breathe by means of gills—delicate membranes with a copious blood supply. The gills are in contact with the water, and the blood is separated from it only by a thin skin. The blood absorbs oxygen, which is held in solution in the water, and gives up the waste product carbon-dioxide. In the second stage, breathing takes place by means of a pair of sacs, the lungs, which are outgrowths from the pharynx, or region of the food passage immediately behind the mouth cavity. The lungs are thin-walled and the inner surface is thrown into ridges ; like the gills they are abundantly supplied with blood which flows in hair-like vessels in the walls. The process of exchange of gases is the same. Amphibians swallow air from which oxygen is extracted. A regular pulsating movement in the throat can be observed.

The skin is naked with no outgrowths such as hair, and there are no claws. Usually the skin is kept moist by a watery secretion. This is important as, in addition to breathing by lungs, amphibians breathe to some extent through the skin.

Amphibians belong to the so-called “ cold-blooded ” animals, but this really means that they cannot control the temperature and keep it at a higher level than the surrounding atmosphere. Therefore, in the winter months the temperature falls and the animals become torpid. They are true hibernators.

The first stage in the life history after the egg hatches is in many respects fish-like, the newly-hatched creature being called a tadpole. The change from gill-breathing to lung-breathing takes place gradually, and before the tadpole leaves the water it is using both means. The tadpole is limbless, but the adult has two pairs of legs, with well-marked toes. Some adult amphibians spend a considerable time in water, though they

must rise to the surface to breathe, but others only revisit it to lay their eggs, which are generally spawned, that is, male and female cells are ejected into the water where they mingle together, enabling the male cells or sperm to penetrate and fertilise the egg cells.

The Common Frog.—Length, about 3 in. Frogs spawn in February or March, depositing masses of eggs which at first sink to the bottom of the water but presently become buoyant by the absorption of water in the surrounding layer of mucilage. This slimy envelope spaces the eggs so that they have room to grow without pressing upon one another, as well as holding them together and making them difficult to seize. It is *not* food. The eggs are black at the upper pole, which is the germ, but white underneath. The tadpoles which hatch have a large oval head-body and flat muscular tail, for swimming. At first there is no mouth, but after a few days horny jaws appear. Three pairs of feathery gill-tufts appear on either side of the head in the “neck” region (there is no neck) and, later, these are covered by a flap of skin, leaving only a little spout at the left side through which water can escape. The external gills are replaced by gill-slits, three pairs of perforations in the pharynx, on the walls of which internal gills develop. Water passes in through the mouth and out over the gills. Finally, these in turn give place to lungs.

The tadpoles feed voraciously on water-weeds, and, later, on a mixed diet, seeming to appreciate meaty additions. They grow rapidly, at the same time beginning to develop a pair of hind limbs which soon foreshadow the elongated legs of the adult frog. Then the front legs develop, but for some time are hidden inside the pouch which covers the gill-slits. At last they break through. Then the animal sheds its horny jaws. It is now ready for the final change; the head becomes broadened and flattened, the eyes much larger, the mouth acquires its wide gape. The lungs are used more and more. The dark colour of the tadpole gives place to the mottled brown and yellow of the frog. Finally, the tail is absorbed back into the body—resorbed. The young frog leaves the water. The body has become comparatively slender and angular, with the characteristic projections in the middle of the back, caused by the ends of the pelvis, which is curiously lengthened in connection with jumping. The front limbs remain short and stumpy, but the hind legs are two and a half times the length of the body, and have particularly long toes joined by webs. They are powerful both for leaping and swimming. The eyes are high up on the head, giving a wide all-round view. The whole development takes about three months.

The common frog feeds on flies and other insects, and worms. Its tongue is attached just inside the lower jaw, the tip lying towards the

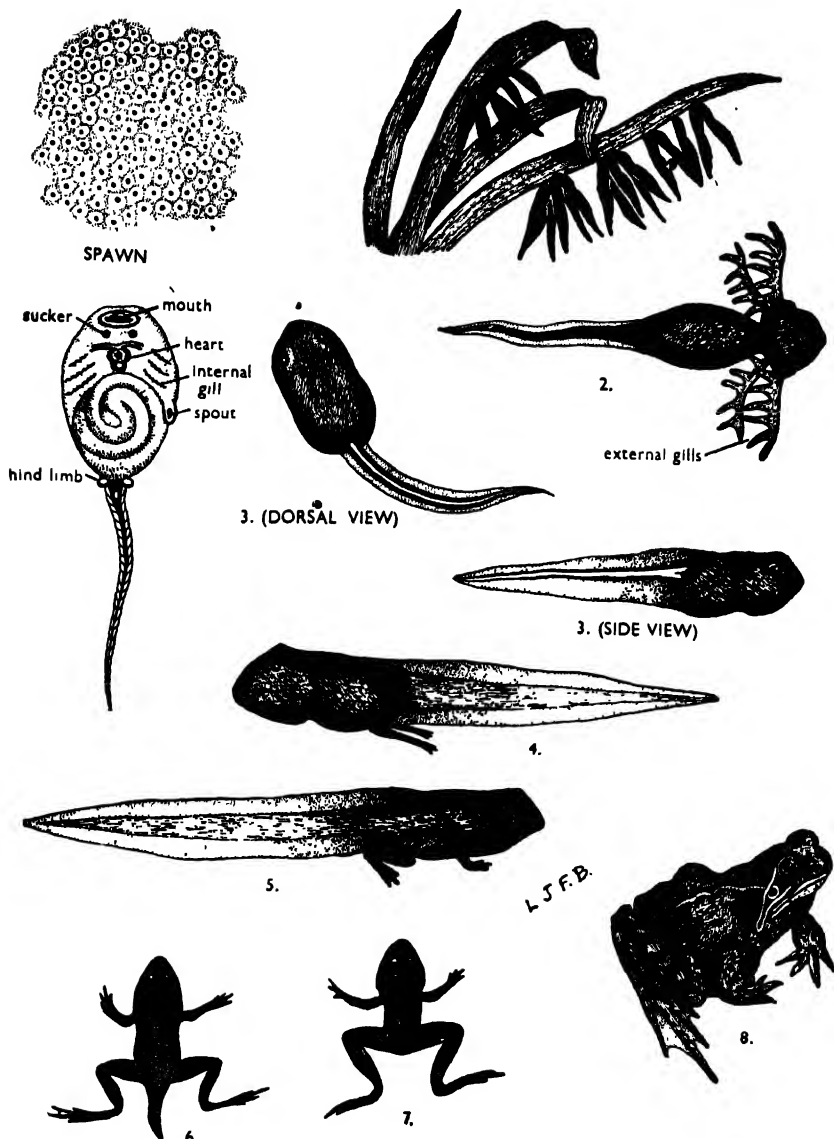


FIG. 18. Metamorphosis of the frog.

throat. It can be shot forwards with lightning speed to catch an insect on its sticky surface, and whipped back again. To help in swallowing food frogs retract their eyeballs, which press downwards into the mouth cavity, since there is no bony eye-socket.

The common frog has a great capacity for changing colour to match its surroundings. The colour or pigment cells can be greatly expanded, or contracted, through the agency of the nerve supply, in response to changes of light. Thus the skin can be suffused with dark colour, or retain its natural yellowish ground tint.

The Common Toad.—Length of male, about $2\frac{1}{2}$ in. ; female, about $3\frac{1}{2}$ in. The toad differs from the frog in having a broader, clumsier body, with shorter hind legs and dingier, more uniform colouring of dark greyish-brown, though it, too, has some power of changing colour with varying surroundings. The skin is drier and appears granular, and it can secrete an acrid substance which is unpleasant and slightly irritant, if handled. The toad crawls or gives short, heavy hops, instead of leaping. Toads will spend hours squatting in a shallow hole which they dig out of the soil, remaining perfectly still ; hence the expression "toad in the hole."

Eggs are laid in water, but in ropes coiled round water-weeds, not in an extensive mass as with the frog. From these eggs hatch tadpoles with a similar life history ; they take about three months to become toads, but it is five years before they are mature.

The Crested Newt.—Length, about 6 in. Newts differ from frogs and toads in having a slender, elongated body, narrow, snake-like head flattened above and below, and long tail. The head is joined to the trunk without a definite neck, as in all *Amphibia*, and the tail is flattened from side to side and forms a powerful swimming-organ. Crested newts are seen at their best in the mating-season, especially if they can be watched swimming in clear, shallow water. Their power and agility in swimming are very striking, and their colouring brilliant. The male has a strongly-marked frilly crest running along the neck, back and tail, and continuous on the underside of the tail to the vent. The skin is very dark olive-brown, almost black, on the back, sides and head, while the pearly under-surface is deeply suffused with bright orange, splashed with black spots, which extend up the sides. Small rough excrescences on the body have given this newt its alternative name of warty newt. The eyes are bright gold. There are four fingers on each hand and five on each foot, and these are splayed out into slight discs at the tip, a feature which no doubt helps them in climbing, for they seem able to scramble up a perfectly smooth surface, such as the side of a glass tank. (The number of digits is the same in frogs and toads.)

The female is actually larger than the male, but she appears smaller because of the absence, or very slight development, of the crest. She is browner and her colouring is altogether less brilliant, the orange tinge of the underside being fainter.

The Common Newt.—Length, $3\frac{1}{2}$ –4 in. This is a much smaller species than the crested newt. The skin is quite smooth, a pale olive-brown to dull fawn colour, with lighter underparts coloured fairly bright orange in the male during the breeding-season, and spotted with irregular dark brown spots. The male has a fairly well-marked crest, but it is not notched. The female is quite smooth. This species is sometimes called the smooth newt.

Both newts breed in the shallow water of ponds and ditches. Each egg is separately laid on the leaf of a water plant, such as watercress or starwort. If possible the leaf is doubled over the egg to enclose it. A tadpole which hatches out is much lighter in colour than that of a frog or toad. The body is not so rounded and solid, and it is semi-transparent, pale brown or olive with delicate, dark spots. It might easily be mistaken for fish fry, but on closer examination, three pairs of long, plumed gills can be seen streaming in the water. The tail fin is almost transparent. Development is gradual, and there is no marked external change from the larval to the adult stage except that the gills are eventually lost. The two pairs of limbs develop, at first appearing almost thread-like. The body becomes rounder and more opaque. By the end of the summer the tiny newt is complete.

Hibernation takes place in some sheltered corner in a ditch or between tree roots, protected by heaps of damp dead leaves. Loss of moisture would be more serious than cold. It is said that sometimes many crested newts hibernate together, coiled into a ball.

PLATE 20. FLESH-EATING ANIMALS

Introduction.—The four animals shown on this Plate are all flesh-eating or carnivorous mammals. They have in common a certain ferocity of temperament, for they appear to kill for the sake of killing. The teeth vary in detail in the different families but have similar characteristics, consisting of cusped molars or cheek teeth for tearing and biting the flesh, and strong, pointed canines for gripping the prey. The incisors or front teeth are reduced and little used. The jaws are strong and have powerful musculature.

These flesh-eaters all live in holes and their bodies are protected from the weather and the damp earth by thick coats of warm hair or fur.

Family life is well developed among the flesh-eaters, which fiercely defend their young and teach them in play to prepare for a life of hunting and killing.

The Badger.—Length, 2 ft. 6 in. This mammal belongs to a family which includes the stoat and the otter, figured on the same Plate, the marten and the now very rare polecat. The fierce hatred shown for the badger by many country people, who credit it with ferocious attacks on dogs and the devastation of game preserves, is not justified by its disposition and habits. If cornered, it will turn and strike strong blows with its formidable claws, which might perhaps, as is said, rip open an adversary, but it is of a retiring habit and will, if possible, avoid all meetings, hunting secretly by night and leaving its den or “sett” by obscure ways. The sett, which has several entrances, is usually in some quarry or under overhanging cliffs, perhaps in the high bank of a stream well hidden by bushes. A mound of excavated earth and possibly some old bedding of grass and leaves, mixed with a few black and white hairs, often both conceal and indicate the opening.

The badger is heavy, with a clumsy, swinging gait. It weighs about forty pounds. Its coarse, long hair is reddish-grey above, black beneath, with a white forehead and cheeks, and two conspicuous black bands stretching from the snout back over the eyes and ears to the nape. The tail is broad, the legs short and strong, and the powerful claws are used for digging, at which the animal is adept. It is strictly nocturnal, returning to cover with the dawn. It is slow-moving and can only stalk its quarry, relying largely on a keen sense of smell to track down wounded rabbits, birds which have fallen from the nest, young rabbits hidden deep in the ground, which it will dig out with uncanny precision, or wild bees' nests which may yield honey or grubs. In addition, it feeds on earthworms, snails, slugs, birds' eggs, small reptiles and frogs, and is not averse from roots, fruit, acorns and nuts. The badger's one really objectionable trait, from the farmers' and gamekeepers' standpoint, is its love of the young and eggs of partridges, pheasants and other game-birds.

Badgers retire for the winter to a deep underground chamber, bedded with moss and dry leaves, but in mild spells they make occasional excursions for food, like most so-called hibernating mammals. The young are born in specially-prepared nursery chambers.

The Stoat.—Length, 11 in. This animal has a slender body borne on very short legs, a small, flattened head and beady eyes set wide apart. Its long, rather bushy tail is tipped with black, a feature which distinguishes it from the male weasel, which nearly approaches it in size, though its tail is proportionately shorter. The stoat has a light reddish-brown coat, almost white on the underparts. The ears are short and rounded. In fact, the whole shape and colouring are extremely well adapted for the life it leads, for its chief quarry is the rabbit, which it will chase through

narrow openings and even into the warren, darting down a burrow and pursuing its victim with unswerving concentration till it makes a kill. There seems no doubt that a stoat can at times exercise fascination over its victims. The snake-like appearance and sinuous, rippling movement may contribute to this. With a final pounce, the stoat fixes its needle-like canine teeth just below the ear, piercing the jugular vein. Although the rabbit shrieks wildly with fright, it is probable that its death is almost painless. Fish and young game birds are also eaten, besides all sorts of smaller fry.

In northern countries the stoat turns white or yellowish-white in the winter, when it is known as ermine. In this way the colour harmonises with the snow-covered ground and so the animal cannot be seen by its victims. But this protective device can hardly be regarded as a complete success, since it takes place in Scotland and Northern England, which have by no means continuous snow even in very cold weather.

Four or five young are born in a nest in a hole in the ground or amongst the roots of trees.

The Fox.—Length, 3 ft. The fox belongs to the *Dog Family*, as its whole frame, head, and teeth proclaim. It has an agile, muscular body, borne on slender legs with five front toes and four on each hind foot. The claws, like those of a dog (and unlike a cat's) are not retractile. The prey is seized by the strong jaws, and held by the sharp canine and molar

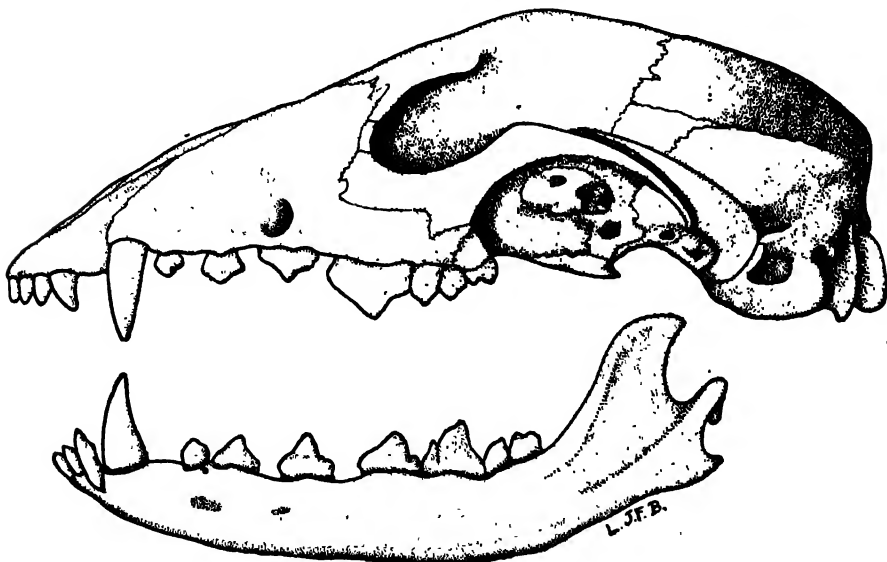


FIG. 19. Skull of dog.

teeth. The molars have well-developed cusps for tearing flesh. The ears are rather large, pointed and set well back and high on the head. The reddish-brown hair of the body and bushy tail blend well with the landscape in which it moves, amongst bracken, heather, woods and fallow fields, or stony ground. The whitish underparts, as in so many animals, lighten the shadow thrown on the ground and so make the body appear less solid from a distance, so that it "melts into the landscape." This is called counter-shading.

Although foxes are forced by scarcity of food to eat anything they can find, even field mice, frogs, snails and so on, they are chiefly associated by most people with raids upon farmyards and game preserves. Their cunning, caution and intelligence, both in hunting and in evading pursuit, are proverbial.

Fox cubs are most entertaining, lively little creatures, and the family life is highly developed, for the mother tends the cubs assiduously in their secluded lair, while the father procures food, and the whole family indulges in games which give the cubs their first training in the art of hunting. The lair or "earth" is usually an old rabbit's burrow or, sometimes, a badger's sett of which the fox has taken possession, adapting it for the purpose by stopping up all exits except one "bolt-hole." Like many of the smaller carnivorous mammals, the fox secretes an offensive-smelling substance from glands under the tail—one of the most ancient signposts or means of communication—and as this foxy smell permeates the earth, the animal is usually left in undisturbed possession by others.

The Otter.—Length, about $2\frac{1}{2}$ ft. The otter, although another member of the family of the badgers, stoats and weasels, has taken to the water as its chief hunting-ground, though it may roam widely and extend its diet in hard times. A fascinating and sympathetic account of its life may be found in *Tarka, the Otter*, by Henry Williamson, who stresses the hardships suffered by many of our small animals in bad winters.

One or two young are born at a time in a hole in a bank or amongst tree roots near to a stream. This takes place in winter, and by the spring the young are sufficiently grown to be taken to the water and taught to swim, for, curiously enough, swimming does not seem to come naturally to these animals. It has, at any rate, to be encouraged and confidence must be gained. Once established, swimming becomes the chief means of progress; the otter dives, twists and turns at high speed and with great power, catching fish or water-birds and working great havoc in preserved waters, so that it is not unnaturally regarded as an enemy by those who have fishing rights, and it is hunted almost to extermination. Yet otters manage to survive in the more remote streams and lakes,

probably because they will leave danger areas for a period, and travel over-land by night to quiet pools or inaccessible rocky streams, returning to their home waters when the risk has abated for the time being. Although their main diet is fish, all kinds of water-creatures, such as pond mussels and small shellfish, are acceptable.

The otter has a long, agile body, short, very strong legs and a thick, tapering tail which is used like a rudder. The head is rounded with very small ears which offer no obstruction to the water. The hair is coarse and long, greyish-brown in colour with reddish tips but looking dark and sleek in the water. There is a thick undercoat which does not get wet. The webbed feet give great resistance for the swimming stroke. The otter often floats downstream, the legs streamlined with the body, and only the eyes and nostrils showing above the water. Otters hunt at night, as do all the animals illustrated on this Plate, and they sometimes announce their presence by a shrill, fluting whistle.

PLATE 21. INSECT-EATING ANIMALS

Introduction.—The harmless and even beneficial little mammals belonging to this group are distinguished structurally by their small, needle-like teeth, of a simple form. They are *plantigrade*, that is, they walk with the whole palm of the “hand” and sole of the foot pressed on the ground; they have in nearly all cases five “fingers” and five toes. In connection with their food, the molar teeth have three or four cusps which can pierce the hard skin of insects, while the front teeth in both jaws point outwards and meet to form pincers.

The bats, included in this Plate, belong to a separate family, for their habit of flight has necessitated considerable structural change in the limbs.

The Hedgehog.—There is something very appealing in this quaint creature with its little pig snout, beady eyes, lowly posture and bristling armature. Like so many shy and humble creatures, it uses concealed runways at the bottom of hedges and banks, and ventures into the open only when it must. The hedgehog’s diet consists of worms, grubs, snails and slugs, and any insects it can capture; it has a great fondness for eggs. Probably, too, young nestlings which have fallen from the nest are welcome tit-bits, and it will tackle frogs, lizards and even snakes.

Young hedgehogs are cream in colour or greyish-white. At first their bristles are quite soft, but they gradually harden and become dark. The dead hedgehogs so often found appear to be dull grey all over, but the living animal in good health has brown spines ringed with creamish bands, interspersed with thick, coarse grey hair—dirty-white on the underside.

The spines can be erected, and the body contracted into a ball with the underside and head completely protected. Badgers and foxes are said to be able to kill hedgehogs, but dogs will not tackle them. On the whole, they are highly beneficial in keeping down insects, slugs and snails, and it is a great pity that all kinds of superstitious ideas are still held which make country people countenance or encourage cruelty towards them. Hedgehogs are in the bad books of farmers for the occasional loss of a few eggs or young chicks, but to counterbalance this, they are known to fight with and kill rats.

Hedgehogs may be heard grunting contentedly as they pursue their rounds in the late evening, or snoring as they sleep out the day under dead leaves in a ditch. For the winter, they seek a deep hole, such as a forsaken burrow, or a wasps' nest, which they line snugly with leaves and grass. Here they spend the whole winter, during which food is not to be found.

The Mole.—Length, 5-6 in. The mole is better known by the heaps of earth it turns out than in its living person, for it works almost entirely underground, and the keen awareness of any vibration warns it not to come to the surface while there is anyone near, so that only patient observers are likely to see one.

From its headquarters in the form of a shallow chamber, the mole tunnels in all directions in search of food, its voracious appetite and the unsustaining nature of its food making unceasing work necessary. The tunnels are straight shafts (but winding in the case of the female) with

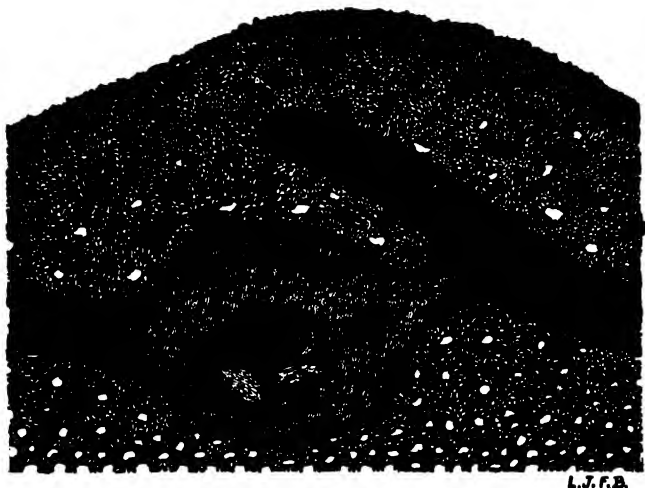


FIG. 20 Section through burrow of mole.

their walls worn smooth and firm by continual passage backwards and forwards. The earth removed is thrown up at the surface in the familiar tumps, the main chamber being covered by a shallow dome about a yard across. The mole's chief diet is earthworms, though no doubt the larvæ of beetles, such as cockchafer grubs and wireworms, are eaten when they are met. A mole will die of starvation in a few hours. It is said by some country observers that the need for constant water is equally urgent.

The objection of farmers and gardeners to the presence of moles is due to the interference with processes of cultivation caused by their heaps of soil. In fact, however, by reducing the numbers of grubs and, in the long run, by turning over the earth so that new soil is brought to the surface, they probably improve the soil conditions and reduce plant pests. Where earthworms are too numerous they may also be held in check by moles.

The female lives solitarily, constructing a similar but less extensive system of runs, with a nursery chamber containing a nest of leaves and grass. The four or five young are blind, naked and at first helpless. They are pink in colour, turning bluish-grey before the hair grows. The mole is prized for its thick, silky coat of dark elephant-grey, hence the mole-catchers who work for the farmers never destroy the nests, since they increase their livelihood by selling the skins.

A mole's structure is delicately adapted to its burrowing habit. The thick cylindrical body is covered by close, short, upright hair which will bend either backwards or forwards as the animal moves along the tunnel, and there are no projections. There are no external ears; the eyes, which might get filled with soil, are deeply sunk in fur and very small, and the animal is practically blind. The long, narrow snout searches out worms or insects in the loosened soil; the sense of smell is very acute. Perhaps the most striking feature is the broad, spade-like, five-fingered hand, turned backwards and outwards on a short, strong arm, to form a most efficient scoop or shovel. This is the tool with which the excavations are made. The claws are strong and well-developed. As the hand scrapes and throws out the soil, the sensitive snout sifts it for food.

The Common Shrew.—Length, $4\frac{1}{2}$ in. to the tip of the tail. Shrews resemble moles in the general shape of the body, small, sunken eyes, long snout, short legs and short, plush-like dark grey fur. They have not, however, the burrowing habit and correlated structure of the feet of the mole. They are like moles in their voracity, for it is said they will die of hunger if deprived of food for three or four hours. They expend a great deal of energy, are active, fierce and pugnacious, always fighting one

another, shrieking and squealing. Most of them live only about a year, as if this high pitch cannot be kept up for long.

They make runs in grass and undergrowth and hunt for slugs, caterpillars, spiders, beetles, worms and any other small fry. They have an unpleasant odour which other animals dislike; owls are known to eat them, but other animals, including cats, may kill but will not eat them.

The Common Bat or Pipistrelle.—Wing expanse, from 6–7 in. It will be noticed that the majority of our small mammals are nocturnal in their habits, and the bats follow the rule, flying in the dusk in search of insects which they catch on the wing. Their needle-like teeth resemble those of the Family of *Insectivores*, but they must be placed in a separate family, because the fingers of each hand are lengthened to support a wing of parchment-like skin, which extends down the side of the body and is attached to the hind leg and to the tail. During flight, the fingers are extended like the ribs of an umbrella, but are folded against the arm, which is also flexed at the elbow, when the wing is closed. Bats sleep in the daytime, hanging upside down by their hind feet in some secluded place, such as a cave, a niche in a stone building, the rafters of a barn or country church, usually in large numbers together. They also sleep through the winter though a rise of temperature may bring them out for a short flight.

One or two young are born at a time and carried about by the mother, clinging with their claws to the fur under the body.

The common bat is only about $1\frac{1}{2}$ in. long, with a 1 in. tail, the tip of which is free from the wing membrane and is able to cling to a twig or rough surface. The ugly little face is broad, with prominent eyes and triangular ears, with an inner lobe reaching halfway. Between the nostrils and eyes are several small swellings. The common bat is also the smallest species. Its fur is reddish-brown. Like all the bats, it has a well-developed claw on each thumb by which it clings to rough surfaces. This bat flies all night, in contrast to others which time their flight according to that of particular insects on which they prey. It has a thin, high squeak, beyond the range of many human ears.

The Long-eared Bat.—Wing expanse, about 9 in. The outstanding feature of this bat is indicated by its name, for its ears are very long and are joined at the base. There is a long inner lobe, prominent when the bat is at rest, because the outer lobes are then elaborately folded. This bat is almost as common as the common bat—perhaps more so in some places. It frequents trees, flying among the branches to examine the leaves for insects, which it frequently eats on the ground. Bats can only shuffle in an ungainly way on the ground owing to the modification of

their limbs. Even the hind leg is impeded by the wing attachment, since the knee is turned backwards.

PLATE 22. LIZARDS AND SNAKES,

Introduction.—Reptiles are higher in the scale of vertebrates than amphibians, but lower than birds and mammals, whose ancestors were undoubtedly reptiles of the geological epoch known as the *Mesozoic*. Reptiles have a well-developed bony skeleton, more advanced than that of the amphibians in having distinct ribs. Most of them have two pairs of limbs with five toes on both fore and hind limbs, and well-developed claws.

The name reptile means *crawling* or *creeping*, and though many reptiles are very active, they scarcely raise the body above the ground, for the bones of hip and breast girdles are not sufficiently consolidated to support the weight of the body in such a position.

The skin is dry and covered with small, horny skin out-growths called scales, essentially different in structure from those of fish. The skin is no longer used for breathing. The protection of the skin against loss of moisture, and the fact that it need not be kept moist for breathing, are important factors in setting the animals free of a watery environment. They no longer need to keep close to marshes, riversides or jungles, but can roam widely and populate dry, or even arid land. Incidentally, many reptiles such as snakes and lizards are found in desert regions, where their horny skin is an excellent protection against too great sun-heat. Many of them slough the outer layers of skin periodically, exposing a new, clean layer underneath.

The head is narrow, oval or triangular, flattened from above, and without external ears. Teeth are numerous and in most cases simple and shaped like curved prickles.

Reptiles lay large, yolky eggs, protected by a tough, parchment-like or hard shell. In most cases these are hatched by the sun's heat, or by heat due to fermentation of dung or vegetation amongst which they are laid. They are not incubated by the parents.

The Common Lizard.—Length, male 5-6 in. ; female, up to 7 in. Britain is not well supplied with reptiles, which are more numerous in dry climates. Even the common lizard is not so common as to be familiar to everyone, for though it is widely and generally distributed in both Great Britain and Ireland, it favours sandy heaths and dry, sunny situations. The tail is as long as the body, which is long and slender, tapering to the small, slightly, pointed head. There is a definite neck—another

advance on amphibians. The scales are small, and on the underside, where they are larger, arranged in transverse rows. The limbs are short and spread out sideways. When at rest, the front part of the body is slightly raised, with bent elbows, the hinder part lying on the ground. The movements are extremely quick and the tail no doubt helps in both direction and balance, as well as in actual propulsion, much as the newt uses its tail in water. Like most lizards, it has the astonishing trait of shedding its tail if caught by it. The eyes have lids which can be closed. The colour is brown, varying from light yellowish or hazel-nut-brown to a dark bronze shade, with irregular dark spots forming broken longitudinal lines.

The eggs are retained by the mother till after the young are hatched, when they are dropped and discarded. This lizard feeds on all kinds of insects, which it can catch with great skill. The front of the tongue is divided into two rounded lobes.

The Slow Worm.—Length, about 14 in. The so-called slow worm or blind worm is neither slow, blind nor a worm. Neither is it a snake, nor harmful, though appearances are against it. It is a legless lizard, with vestiges of legs still present under the skin and flesh. It agrees with the lizards both in the lobed (not forked) tongue and in the presence of eyelids.

The slow worm is, then, a long, slender lizard without legs, which behaves like a snake in its movements. It is light brown in colour, with small scales, so minute that a lens may be needed to perceive them, though they are larger on the under surface and have the hinder end free and rounded. It has a very small mouth and feeds chiefly at dusk and through the night on a little greyish-white slug which is a garden pest, though it will also feed on tiny insects. Like other lizards, it will leave its tail behind very readily when attempts are made to catch it. In the daytime it remains hidden, often under a flat stone. Like all British lizards it hibernates, seeking a hole in the ground or a hollow tree, and frequently congregating with others. In early spring it may often be seen basking in the sun at the edge of a wood or heath. Like the common lizard, it retains its eggs till the young are hatched.

The Viper or Adder.—Length, 20–25 in.; female slightly larger. This is the only venomous British snake. Its bite can be serious and in some cases fatal to man, dogs and other animals. The two outstanding markings are a dark zigzag line along the back and two bars forming a V-shape on the head. These markings may vary, and their colour may be rather pale, so that they do not stand out very clearly from the brownish or olive-green ground colour. Along the side are pale lozenge-shaped

spots. The males may be so light as to be ash-grey, with brown or black markings and dark undersides.

The head is triangular, narrowing to a slight neck. The body is long and the tail (behind the vent) short. (This is reversed in the slow worm.) The irises are bright, coppery red, and the eyes unblinking, for they have no eyelids to close. Actually, the upper and lower eyelids have joined over the eye, protecting it, but the lower is transparent and the snake sees through it. The tongue, as in all snakes, is forked, and darts in and out when the animal is excited, or it is used merely as an organ of touch. The venom is contained in sacs at the base of two large hollow teeth, or fangs, which lie against the roof of the mouth, but swing erect when the mouth opens.

Like all snakes, the viper has a very large gape, due to elastic fibres uniting the two halves of the lower jaw, and to the fact that some of the bones of the skull and jaw are very movable.

Vipers are found in similar places to those of the common lizards—sandy heaths and dry meadows with long grass, and sand dunes. They may also be met with on marshy ground and near water, possibly in search of frogs, though their chief food is small mammals and birds. They hibernate in dry, sheltered situations, sometimes choosing an old bird's nest on the ground or the burrow of some small animal. Like the lizards described, vipers retain their eggs till the young are ready to hatch. Perhaps this constant habit may be connected with the inclement British climate, since in hot countries, the eggs are usually hatched by the sun or the heat of manure heaps.

Lizards and snakes shed the outer layers of the skin periodically—the viper several times each year. The sloughed skin is a perfect cast of the body, even to the covering of the eyes. The skin becomes loosened round the mouth, and the snake works part of it backwards by pushing against the ground, till the head is free. Then it pulls itself out, pulling the cast inside out much as a glove may be stripped from the hand.

The Grass Snake.—Length, about 3 ft. This is our largest British snake, and quite harmless. It is about a foot longer than a viper, and very slender, with a narrow head. The colour is olive, brown or grey, with a well-marked collar of yellow or orange, behind which are two black patches, or one bar. Two rows of black dots along the back, and two rows of short upright bars on the sides complete the markings, though if the reptile is turned over, the underside is seen to be chequered with black-and-white. Snakes obtain their hold on the ground, in order to move, by means of the hind edges of the under scales, which dig into the ground. These scales are in the form of transverse plates, attached to the

ribs. The intercostals are the locomotory muscles, the ribs are the "legs," and the under scales the "feet."

Grass snakes feed chiefly on frogs and other amphibians, so in the spring they are to be found mainly in the neighbourhood of water. They hibernate in some dry spot. Their eggs are laid in decaying vegetation or manure heaps, where the heat set free by fermentation incubates them. In this respect they differ from the viper and the British lizards.

Although harmless, grass snakes may be a little alarming to the unaccustomed beholder, as they hiss and dart out the forked tongue and, if captured, give off a foul secretion smelling of garlic.

WILD FLOWERS

Introduction.—The flowering Plants (*Phanerogams*), which are the seed-bearing plants, are divided into the *Gymnosperms* and the *Angiosperms*. *Gymnosperms* have the seeds either exposed, or protected only by scales. The majority are arranged in the form of cones. *Angiosperms* have the seeds completely enclosed in a structure lying in the centre of the flower, the pistil, which ripens into the fruit. In both *Gymnosperms* and *Angiosperms* sexual reproduction takes place by means of egg-cells which are fertilised by male reproductive cells. The male cells are produced in the tubes which grow out from the pollen-grains, and the female or egg-cells in ovules. To bring about union of the two kinds of cells, it is necessary to bring the pollen-grains into contact with the ovules, either directly, or into such a position that the pollen-grains can germinate and thrust out penetrating tubes, down which the reproductive cells can pass to the egg-cells. The union of two cells results in the formation of the germ or embryo, while the surrounding tissues of the ovule become the food store (*endosperm*) and outer covering (*testa*, or integuments). The whole ripened structure is a seed.

A flower is a modified branch bearing pollen-grains and ovules. These are the only absolutely essential parts and may be found separate in different flowers or even on different plants. In the *Gymnosperms* they are always in different flowers, but in the *Angiosperms* it usually depends on whether the pollen is wind-borne or not. It has been found that more vigorous plants result from cross-breeding, that is, the transfer of pollen to ovules of a different flower, thereby causing the union of distinct inheritances. In flowers which have both ovules and pollen, we frequently find devices for ensuring that mating will *not* take place. The simplest precaution is to have pollen and ovules mature at different times.

Great elaborations of structure are found among flowers. The clue to understanding their significance can always be found in the requirements for pollination, or the carrying of pollen to ovules. Insects and wind are the chief agents of pollination. In a few cases water may bear the pollen. It will be well to consider briefly the influence of insects and of wind.

Insect pollination.—A typical insect-pollinated flower is a very highly developed shoot or branch. It consists of several series, or whorls, of floral leaves.

(1) THE PISTIL.—This is a structure enclosing ovules in its basal portion, known as the *ovary*, and drawn out at the tip into a receptive portion for

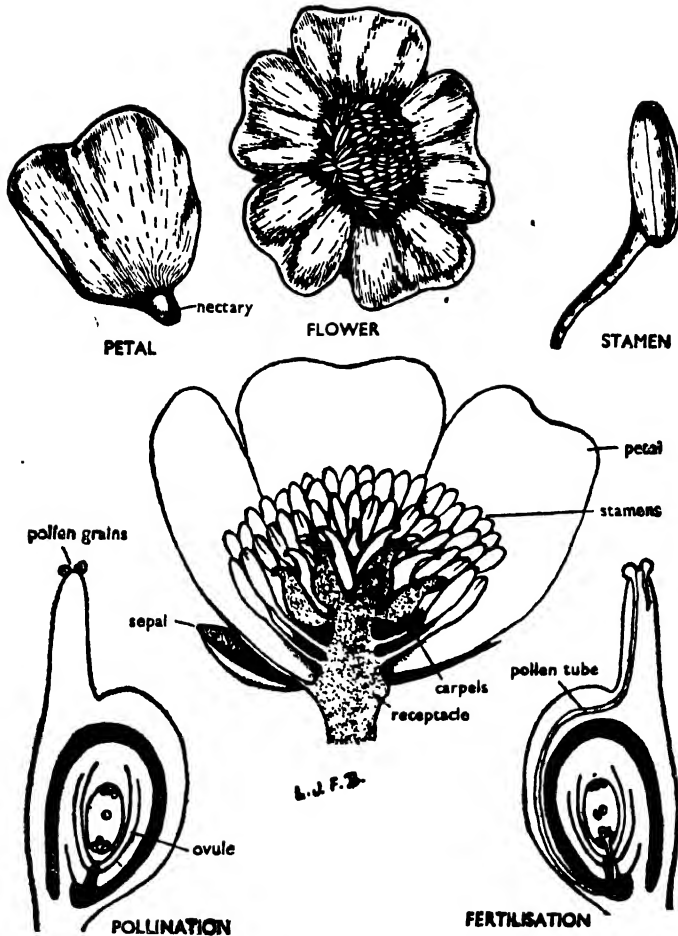


FIG. 21. The buttercup flower and its parts.

the pollen grains, the *stigma*. The stigma may be sticky, rough or hairy, to hold the pollen securely. If the flower has a long tube, the stigma may be brought to the top of the tube by the growth of an intermediate stalk-like portion, the *style*.

The whole pistil may be formed from a single leaf-like outgrowth of the flower shoot, called a *carpel*, or it may consist of several carpels, and as these may be joined together and modified in many different ways, they are used as a basis in classifying flowers. The pistils of the *Pea Family* are examples of a single carpel, while the *Lily Family*, for example the tulip, exhibits a pistil with several (three) united carpels, which may be

clearly seen by cutting across the ovary of a withered flower. The hyacinth shows a pistil with clearly demarcated stigma, style and ovary. a

(2) THE STAMENS.—Surrounding the pistil is a ring, or more than one ring, of stamens. These are the structures which bear the pollen-grains. They consist of oval bodies, the *anthers*, enclosing the pollen-grains in small sacs, the *pollen sacs*, and borne on slender stalks called *filaments*. When the pollen grains are ripe, the sacs burst by the withdrawal of water and release them. They are then carried on the heads and bodies of insects to another flower, where some of them will be likely to fall or be brushed on to the stigma. They are usually sticky. The pollen tube then grows, as already described.

(3) THE COROLLA.—Outside the stamens there will be one or more whorls of *petals*, forming the corolla. These are brightly coloured and serve to attract insects. They may be simple round or oval leaves, or elaborately altered in shape to perform various functions ; for example, in the sweet pea the upper petal is enlarged into a conspicuous standard, while the remaining four petals enclose and protect the vital parts, as well as forming an alighting board for insects. The petals may be free or united. Union of the petals into a tube usually makes access to the flower more difficult, and therefore limits the visiting insects to those which have sufficiently long tongues to reach the concealed *nectar* at the base of the tube. Bees, and to some extent butterflies and moths, which comply with this requirement, have the useful habit of visiting one kind of flower systematically and so are more likely to bring about pollination than the more erratic insects. Flowers can be pollinated only by pollen from the same kind of flower, and only the same species of reproductive cells can unite.

(4) THE CALYX.—The last whorl, or whorls, of floral leaves are the *sepals* forming the calyx. They are usually green and their function is to protect the bud and sometimes to hold the parts of the flower together. Occasionally, they are attractive, like petals, as in the anemone and some other members of the *Buttercup Family*. In the monkshood, for instance, the sepals are bright purplish-blue, forming a hood over the rest of the flower, while the true petals have been reduced and changed into small tubes which secrete nectar, the *nectaries*.

In flowers where the floral leaves are alike and not distinguishable into petals and sepals, they are called the *perianth*, or perianth leaves ; for example, daffodil, hyacinth, and the minute, reduced floral leaves of the alder.

(5) BRACTS.—It is very common to find one or more green leaves attached just below flowers, as in the anemone, or lower down the flower

stalk as in the marsh marigold. These are called bracts. The official definition of a bract is "a leaf subtending a flower." Where a flowering branch consists of many flowers it is called an *inflorescence*, and in that case each flower may have one or more small bracts, called *bracteoles*, as in many of the *Parsley Family*.

Relationship between flowers and insects.—There seems to be no doubt that the forms of insect-pollinated flowers have actually been controlled and guided by the desires and preferences of insects. The control is a simple one. Where insects are necessary to pollination, flowers which are not visited produce no seed. Hence plants whose flowers insects did not like would die out. Variations which made flowers more attractive, more accessible, or alternatively, less accessible except to select visitors such as bees, would tend to be perpetuated and so give rise to new forms.

Botanists honour the names of three German naturalists for their work in discovering how the activities of insects brought about pollination, and what characters in shape and colour attracted them. They are Pastor Christian Conrad Sprengel, in the late 18th Century, and Hermann and Fritz Mueller, the sons of another pastor, at the beginning of the 19th Century. Charles Darwin, too, was an equally important contributor to this subject. There is not space for details here, but readers who are interested are referred to *The Flower and the Bee*, by S. H. Lovell (Constable).

In return for the service of pollination, the flowers offer insects a choice of dainty fare. Pollen is frequently produced greatly in excess of the needs for pollination and insects are welcome to use some of it as food. Some flowers offer only pollen; for example, the wild rose with its numerous stamens. Many offer the sweet juice known as nectar, which may bubble out from the cushion from which the flower-parts spring at the base of the stamens and petals. In some cases there are special nectaries, such as the modified petals of the monkshood, the small scales at the base of the buttercup's petals, and the modified stamens which lie in the spur of the violet. From nectar, honey is made, and from pollen, bees knead for their young the soft pulpy food known as "bee-bread."

It was Sprengel who first noted the markings on flowers to which he gave the name "nectar guides." The first example to engage his attention was the yellow circle on the bright blue background of the forget-me-not. This flower, therefore, has a specially noteworthy place in the story of flowers and insects.

Nectar-producing flowers usually have short "factory hours," mostly coinciding with the sunny hours of the day and with the hours of flight of

their particular visitors. Dull, cloudy or rainy weather, or a low temperature will stop the nectar flow. Sleep movements may be closely connected with this. Many shallow, cup-like flowers, for example silver weed, produce such copious nectar on good days that it can be seen brimming in the cup. (Teachers planning individual studies for children might bear in mind the possibility of making accurate observations on such points as these.)

Wind pollination.—Gymnosperms are all wind-pollinated and there is easy access for the pollen either to the quite naked ovule, as in yew, or by the edge of the open scale which protects it. In Angiosperms, wind pollination seems to have been adopted as a secondary method, judging by the signs of reduction or complete loss of perianth leaves and other parts. Their floral structure is highly complicated and will not be discussed here. Wind pollination seems to be specially suitable for plants whose flowers precede the opening of the leaves, especially if they are held well above the ground and exposed to the wind, as in many early-flowering trees and shrubs. Other plants which hold their flowers clear of the foliage also find the method effective ; for example, many trees and the whole of the flourishing family of *Grasses*, together with their relations, the *Rushes* and *Sedges*. Occasional examples may be found in other families where the conditions are similar, for instance, the burnets in the *Rose Family*, which grow amongst grass and hold up their flowers in the same way above the general level of foliage.

In addition to these characteristics, the following are the chief points to be noticed :

(1) The pollen is copious, light and dry. It is not sticky and is much smaller and finer than amongst insect-pollinated flowers.

(2) The filaments are long and slender, so that they shake in the wind and thus scatter the pollen.

(3) The inflorescences have stalks, so that they, also, toss in the breeze.

(4) The stigmas are long and protrude well beyond the flower, so that they catch the pollen. They are rough and frequently feathery or hairy.

(5) Wind-pollinated flowers are almost invariably gathered together into inflorescences. (The flowers of hazel exemplify all these points.)

Although in many cases, as in hazel, there are separate pistillate and staminate flowers in distinct inflorescences, in other cases, as in *Grasses*, each flower combines both parts.

It may be noted that willows, though at first sight they suggest it, are *not* wind-pollinated. They attract clouds of bees for whom they provide the first great nectar flow of the year. The pollen-grains of willows are relatively large and sticky.

PLATE 23. BUTTERCUP FAMILY

This is a wide-spread, flourishing Family, chiefly of herbs. *Many of them are poisonous.* The flowers are usually gaily coloured, yellow being especially prevalent. They are circular, or regular, in shape, and all their parts are free from one another. A few are irregular. Notice that sepals, petals (if present) and stamens are attached to the stalk *below* the pistil. Sometimes petals are absent, but the sepals are brightly coloured instead, and serve to attract insects which come chiefly for pollen, though some flowers have nectar. Look for the several distinct parts of the pistil, each enclosing one or more ovules. When these ripen into fruits, they are either dry, one-seeded nutlets called *achenes* (pronounced "a-keens") or little pods, called *follicles*, which split open down one side to let out the seeds.

Buttercup.—Height, 6 in.—2 ft. The picture shows one of the two common field buttercups, the bulbous buttercup, so-called because the stem, just at soil level, becomes enlarged into a bulb-like food store. It is a slender herb with glossy yellow, cup-like flowers. It can be distinguished from its tall cousin by its bulb, and also by the sepals, which are turned backwards or reflexed. It has many stamens and copious pollen. The leaves grow from the bulbous region, and are deeply divided into narrow strips or segments. The fruit is a round, green head of achenes. It flowers in May and June, is a perennial, and appears in great numbers together. It spreads rapidly and is poisonous to cattle.

Marsh Marigold.—Height, 8-18 in. This handsome relative of the buttercup appears in early spring and can be found from March to June. It is also known as kingcup and water blob. The large golden cups, and the glossy, kidney-shaped leaves, make great patches of colour in marshy places. The cup is formed from the sepals; there are no petals. The stems are thick and succulent, and contain large air-spaces to store air, for the water and water-logged soil contain a very scanty supply. A large leafy bract grows below each flower. When gathered, the stems and leaves soon droop through loss of water, for marsh marigolds are thirsty plants, and their delicate surface-skin does not protect them against such loss. The fruits are short follicles.

Wood Anemone.—Height, about 8 in. This frail-looking herb first appears in March in woods and coppices, shivering in the wind or nodding in the sunshine, its lovely pale cup supported on a slender but wiry stem. The flower may be white or shaded with palest pink or mauve. It has no petals, but like the marsh marigold, its cup is formed of petal-like sepals.

Three leafy bracts, each divided into three parts, grow on the flower-stalk below the flower. The fruit resembles that of a buttercup.

The plant spreads from year to year by means of a short stem creeping just below the surface, from which a new bud develops each year into a single flower-stalk and flower. Such a stem is called a *rhizome*.

Columbine.—Height, 1-2 ft. This is not a common member of the Buttercup Family as a wild flower, but is frequently cultivated in gardens. The wild and cottage garden form has a compact cluster of dusky purple petals and sepals, five of each. The petals are drawn out backwards into sacs or spurs, which encircle the stalk. These contain nectar which attracts bees. The cluster of spurs, with the spreading, wing-like petals, is supposed to resemble a ring of doves, and so the flower gets its name from the Latin *columba*, a dove. The fruits are slender, many-seeded follicles. The stalk is slender and the leaves, growing from the ground level and divided several times, are rather like maidenhair fern.

Adonis.—Height, 6-10 in. This again is not common. Its popular name is pheasant's eye. The flower has five to ten narrow, bright red petals. It occurs in the summer months in cornfields. Its leaves are finely divided into narrow strips, much like the under-water leaves of water crowfoot.

Monkshood.—Height, 1-2 ft. This plant is deadly poisonous. The root in particular is often eaten by mistake with serious results. It is not common wild, but does occur on river banks. The flowers, which occur in July and August, are of a dull purple colour, the sepals forming a hood and platform upon which bees can alight, and concealing honey glands or nectaries formed from the petals. This is an example of an irregular flower, an exception to the simple cup-shape of most members of the Family.

Many flowers are clustered round each flower-stalk in a spiral, with the youngest at the top, forming a graceful spray called a *raceme*. Fruits are follicles. The leaves are deeply divided into narrow pointed segments, with five main divisions, and are very dark green.

Lesser Celandine.—Height, 3-6 in. This gay little early spring flower is a close cousin of the buttercup, and has a similar glossy, bright yellow cup, but the petals are narrower, and vary in number from five to eight, with usually three sepals. The leaves are heart-shaped. Just below the ground are numerous small food-storing organs called *tubers*, really a special kind of root, which can be used up as the plant grows. Leaves grow on the flower-stalks, and in their axils, that is, where they join the stem, small swellings appear, which break away when the plant dies down

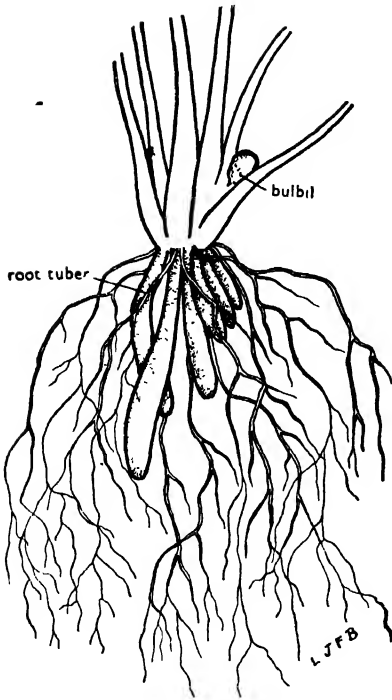


FIG. 22. Bulbils and root-tubers of the lesser celandine.

in the winter, and become buried amongst decaying leaf-mould. When the early spring arrives, these little balls, called *bulbils*, begin to produce roots and leaves and so form new plants. The fruits are like those of the buttercup.

Traveller's Joy.—This is the only wild British climbing-plant belonging to the Family. It is really a clematis, but though not so handsome and striking as the cultivated plants with large purple flowers, it has an attraction of its own, for in the autumn it is covered with a fleecy white mass of silken plumes. These are attached to the tips of the achenes which form the fruits, and serve to carry them away on the wind and so distribute the seeds far and wide. These feathery streamers account for the name of “old man's beard,” by which the plant is also known.

The flowers are small creamy-white discs, borne in clusters. The stems grow several yards long, in a wiry tangle thrown over hedges and banks. They are woody and tough. There are pairs of compound leaves, each with five leaflets, and it is by means of the leaf-stalks that the plant gains a hold on shrubs and trees, for when a leaf-stalk touches a twig, it begins to twist round it. Then the coil is pulled tight and innumerable such coils hold the plant firmly in position.

Water Crowfoot.—Here is another plant which requires support, for its long stems are much too limp to stand alone. Instead of seeking the support of other plants, however, water crowfoot is supported, or floated, on water. It grows profusely in the summer in slow-moving streams, stagnant ditches and ponds. It has starry white flowers, each with five petals and five sepals, and fruits like those of a buttercup.

The chief peculiarity of the plant is that it has two kinds of leaves. Floating on the surface are rounded, kidney-shaped leaves, but submerged below it are finely divided green tufts. It is thought that, by allowing the

water to flow freely between their hair-like segments, these leaves are able to absorb more air from the supply dissolved in it. We have already noted (see marsh marigold) that water-plants find it difficult to obtain sufficient air.

PLATE 24. PINK AND CRANESBILL FAMILIES

PINK FAMILY

The Pink Family consists chiefly of graceful, slender herbs, some annual, some perennial, in which the stems are swollen at the joints, from each of which grows a pair of narrow leaves. The flowers are circular, either cup-shaped or with a flat disc and a tube formed by free petals held together by the calyx, which may consist of either distinct or united sepals. The flower-tube is in many cases long and narrow. The parts are in fours or fives or multiples. The fruit is a capsule opening by teeth at the apex.

Ragged Robin.—Height, 1-2 ft. This slender plant produces its rose-coloured flowers in damp woods and meadows or marshy ground in May and June. It is a *Lychnis* or *Campion*, and its close resemblance to red campion is obvious, but it differs in having the five long petals deeply cut into four narrow segments, which give it its ragged appearance. It has also very narrow leaves at the nodes. The stamens ripen before the stigmas, so that cross-pollination is most likely to take place.

Red Campion.—Height, 1-2 ft. The flowering time, colour, and habitation are much the same as those of ragged robin, but the flower has a neat, compact shape with a flat disc and long tube, and the sepals are dusky red. In both, the sepals, of which there are five, are united, and there are five petals, ten stamens and four to five styles. The leaves of red campion are ovate, and drawn out into a point, and both leaves and stems are downy. This plant has a special device for prohibiting self-pollination; some of the flowers develop stamens only, the ovary being absent or incomplete, while others reverse the position; thus the ovule-bearing flowers are entirely dependent on others for pollen, which can be brought to them only by insects. In this case—as in many circular, tubular flowers—butterflies are the agents, while their white cousins, which open at dusk, depend on moths. Both the red campion and ragged robin are perennials.

Maiden Pink.—Height, 6-12 in. This is a rare plant of hilly pastures—an alpine in fact. It is like a dainty and diminutive edition of the pinks of our gardens. From the slender green tube of the calyx the five pale pink petals spread out, each being attached by a slender claw to the receptacle. The mouth of the flower-tube is marked by a deep red circle,

a honey-guide formed by the separate markings on the petals. There are ten stamens and two styles. Immediately below the calyx there is a pair of overlapping bracts. The leaves are narrow and downy. Only one or two flowers on a tuft open at one time, and the stamens open successively, five at a time, followed by the stigmas, so that self-pollination is unlikely, and the styles receive pollen from younger flowers. There is no scent, but honey is secreted at the base of the flower-tube, which again is only accessible to long-tongued butterflies or moths.

Greater Stitchwort.—Height, about 1 ft. This is one of our commonest hedgerow plants of spring and early summer, flowering amongst long grasses which give its slender, grass-like stems support and protection against dry air. Plucked, it quickly droops. Its height varies with the surrounding vegetation, up to 2 ft. Its narrow, pointed leaves project almost at right-angles from the nodes, of course, in pairs as throughout the family. Its flowers are dainty white cups borne singly on rather long stalks. The plant shows extremely well the typical inflorescence of the family, which is less obvious, though it can be noted, in the foregoing examples. This consists of a main flower-stalk ending in a single flower, with a pair of branches arising below it. These terminate in the same way, and again give rise to a subsidiary pair of branches. Thus there is a repeated forking, as each new axis of growth is stopped by the production of a flower. Such an inflorescence is called a *dichasium*.

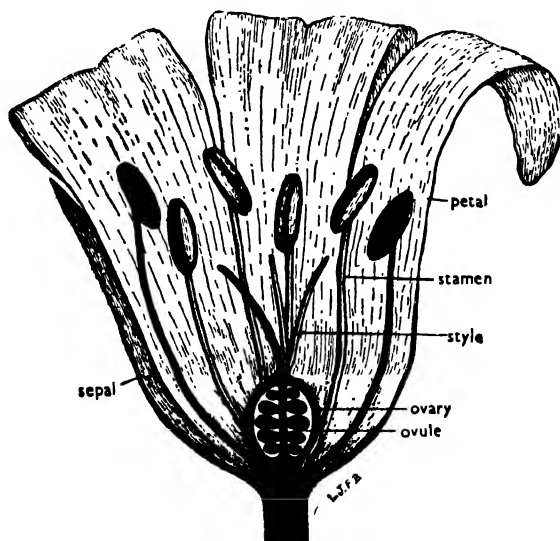


FIG. 23. Section through flower of greater stitchwort.

Corn Cockle.—Height, 1–2 ft. This is an erect, handsome and attractive plant, which must be regarded as a weed since it occurs in cultivated meadows and cornfields. While not very common, it usually occurs in fairly large numbers if at all. The solitary flower is about one inch across, of a beautiful rich reddish-purple colour, with the pointed tips of the sepals projecting between and beyond the petals. It is another of the Campion, or *Lychnis* genus.

Bladder Campion.—Height, 1–3 ft. The most striking characteristic of this plant, which is fairly common in late summer in fields and by roadsides, is the distended calyx which gives it its name. Its flowers are white, and the papery, balloon-like calyx has a purplish tinge. The pollen is chocolate-purple, often smeared over the disc of the flower when ripe. In other respects the plant is much like red campion, though it actually belongs to a different genus, that of the Catchfly or *Silene*.

CRANESBILL FAMILY

The Cranesbills, or Wild Geraniums, have much in common with the Pink Family in their general characteristics, for they, too, are slender herbs with circular flowers, with free petals and sepals attached below the ovary, their parts in fives, with stamens five or ten. The flowers are, however, cup-shaped, not tubular; the leaves are either deeply lobed or compound; and the branching, while of the same type, usually has the terminal flowers suppressed. The most marked feature is the ovary, which consists of five chambers joined to a central rod or column continued upwards as a single style and stigma. Each chamber, or *loculus*, contains one ovule. When the fruit ripens, the loculus splits away from the centre, but remains attached to the style by a long, narrow strip, by which it is swung outward as the tissue dries. This action flings the seeds some distance away. (See drawing of meadow cranesbill fruit on the Plate.)

Meadow Cranesbill.—Height, 1–3 ft. This is one of the most handsome cranesbills, with pairs of reddish-purple, salver-shaped flowers over one inch across. It flowers in June and July in damp places, such as the edges of meadows, osier beds, foot of railway embankments, or where drainage water tends to collect. The leaves can best be described by imagining the leaves of cultivated geraniums (but of, thinner, more delicate texture) deeply divided into five to seven, pointed lobes, and these again jagged into many points. The botanical term “laciniated” suggests “lacerated,” and gives an apt picture. The fruits are striking, with the five-lobed ovary, pointed column, and five sepals enclosing the

base, and still more striking when seen with the loculi sharply curling upwards to release their seeds.

Dove's Foot Cranesbill.—Height, 6–12 in. This little annual is a contrast to its handsome relative. It is a weed of corn land and other cultivated fields, and also of pasture land, downs, and sandhills, where it may be no more than an inch or two high. The whole plant is softly downy and may be more or less procumbent. The flowers are tiny, pinkish-mauve cups, and only the presence of the sharply pointed fruits indicates the aptness of the name cranesbill. It is probably the leaves that give it its specific name of dove's foot. The radical leaves are orbicular, but deeply divided, the stem leaves are similar but much smaller, the stalks are frequently reddish, and in the autumn the leaves, too, may have a scarlet or pinkish tinge. Seen amongst the stubble fields in autumn, the soft texture and colouring make the name not inept.

Hemlock Storksbill.—Height, 3–18 in. This plant is procumbent and very variable in size, an inhabitant of heaths and sandy places, such as sandy shores and dunes. An examination of the cup-like purple flower will illustrate the difference between a storksbill and a cranesbill, for the storksbill has only five stamens while the cranesbill has ten. The fruit should also be looked for. In the storksills, the thread-like strips, called *awns*, to which the loculi are attached, are spirally twisted as they separate. In the cranesbills, they curve outwards and upwards without any twist. The leaves in the hemlock storksbill are feather-like, or pinnate (not orbicular) and the leaflets further subdivided. Note also the candelabra-like cluster of the flowers, or, still more striking, of the fruits.

PLATE 25. FORGET-ME-NOT AND PARSLEY FAMILIES

FORGET-ME-NOT FAMILY

In the Forget-me-not Family the flowers are circular, or radially symmetrical, and the petals are united part way to form a tube. There are five sepals, petals, and stamens, and the ovary is deeply divided into four lobes, each containing a single ovule which ripens into a nutlet or achene. There is only one style and stigma. The inflorescences vary in their method of branching, but each smaller branch curves to one side and gives rise to a succession of flowers, the tip being curled under. This is called a *scorpioid cyme*, from the supposed resemblance to the tip of the tail of a scorpion. In several members of the Family the throat of the corolla is closed with scales, making access difficult for insects and so

narrowing down the possibility of effecting pollination to those with long tongues. The plants are mostly covered with short, rough hairs.

Forget-me-not.—Height, 1-2 ft. There are several different wild forget-me-nots, mostly known as scorpion grass from the shape of the inflorescence. The species called forget-me-not has larger flowers than the rest, and grows at the edges of running streams or in damp places. Its flowers are sky-blue with a ring of small yellow scales closing the throat and providing a honey-guide. It is noteworthy as being the flower which first attracted the attention of the German botanist, Sprengel, the discoverer of the pollination of flowers by insects. His work would have been completely overlooked but for Darwin, whose attention had been called to it. So it may be said that the bright eye of the forget-me-not gave the clue which has led to our modern knowledge of the processes of pollination. The typical, fully developed inflorescence is like that of the stitchwort, with a central flower, the oldest, and paired branches just below it. In this case, however, the branches have the scorpioid arrangement. Frequently, the middle flower is suppressed; one of the branches may also be missing, when the inflorescence will be one-sided. The stem is leafy, the leaves are a long oval, and have no stalks. It flowers from June to August, and is perennial.

Hound's Tongue.—Height, 1-3 ft. This is a sturdy-looking, rather handsome plant, with large greyish leaves covered with soft downy hairs. It has broad lance-shaped radical leaves, with a deep groove at the mid-rib, certainly not unlike a dog's tongue in appearance. The stem-leaves are much smaller and narrower. The funnel-shaped flowers are pinkish-purple or dull crimson; the nutlets are roughly hooked and have a thickened margin. The plant is found on sand dunes and waste places, and is not common. The forked cymes are not markedly scorpioid.

Comfrey.—Height, 2-3 ft. This plant of waste places, rubbish dumps and wet roadsides, is also cultivated for its supposed healing qualities, being in great favour as a poultice for bruises. Its popular name in Lancashire is "knit-bone." It is a coarse-growing plant with large rough leaves, much like dock or horse-radish leaves. The stems are winged in the upper parts and covered with such stiff hairs that they are quite prickly. The drooping, funnel-shaped flowers range from white to pink, crimson, purple and blue. The corollas have the characteristic found also in forget-me-not, and common in the Family, of falling off very readily as soon as pollination is effected. The cymes are crowded and not unattractive.

Bugloss.—Height, about 1 ft. This belongs to the genus *Anchusa*, whose bright blue flowers are so popular in herbaceous borders. Its

flowers are, however, much smaller—about $\frac{1}{4}$ in. across—and it differs from the garden anchusa and the wild alkanet in having a *curved* or *bent* corolla-tube. The flowers are an intense blue—Reckitt's blue—and the whole plant is very bristly.

Viper's Bugloss.—Height, 1–3 ft. This very striking plant always seems to excite interest. It is quite unlike the common bugloss and belongs to a different genus. Unlike most members of the Family, its flower is irregular, not circular, the five lobes of the corolla being unequal. The radical leaves are strap-shaped, the much shorter stem-leaves lanceolate. The upper part of the single stem produces short, stiffly arranged cymes at regular intervals, having the characteristic scorpioid arrangement. The flower-buds are reddish-purple, the open flowers brilliant blue, and the contrast of these colours in the inflorescence is bizarre and striking. The plant is not very common, and frequents light, sandy soils. The pollen matures before the stigmas.

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THE PARSLEY FAMILY

The chief general characteristic of this Family is the fact that the very small flowers are aggregated into flat inflorescences by means of elaborate branching, the primary series of branches arising at one point like the spokes of an umbrella, and a secondary series spreading out similarly. This type of inflorescence differs from the capitulum found in the Daisy Family, in that every floret has a separate stalk, instead of being embedded in a common, cushion-like receptacle. The leaves are in most cases pinnate, and frequently the leaflets are sub-divided and indented so that the effect is fern-like. Perhaps the best-known examples of the Family are the cow parsley or keck, whose snowy masses foam in the hedgerows in May, and the much coarser, bolder cow parsnip or hogweed which follows a little later.

“By their fruits ye shall know them” might be the botanist's motto for this Family, for in many cases the differences between the members are slight and the shape and markings of the minute, dry fruits may be the only definite points by which to be certain of them. The fruits are in pairs, which separate from one another without opening; they are called *schizocarps*, from two Greek words meaning *splitting-fruit*, but this does *not* indicate that the fruit actually splits open. Many of the plants are aromatic, having volatile oils especially in the fruits; e.g., caraway, aniseed. For this reason many are used as flavourings.

Sea Holly.—Height, 1–2 ft. This is a low-growing, bushy plant with blue-green leaves and bluish flowers. The inflorescences are very com-

compact and surrounded by several holly-like bracts. Groups of leaves surround the stem at intervals ; all are jagged and drawn out into sharp, hard points. The stems themselves are also prickly. The whole plant is covered by a waxy bloom (*glaucous*). It is found on dry, sandy shores, and the prickles, the hardness of the leaves, and the bloom are all means of checking the giving off of water, which the plant can ill afford to lose.

Hare's Ear.—Height, 2-4 ft. This very uncommon plant differs from most of the Family in having simple leaves, which clasp the stem at the base so that it appears to grow through them. Their shape gives the plant its name. The inflorescence is small, crowded and yellowish. Small clusters of five-pointed, yellow florets have five rounded bracts projecting below them. It is found on cultivated ground and waste places on chalky soil in the S. Eastern counties only. The fruits are narrow.

Hemlock.—Height, 2-6 ft. It is as well to warn children not to eat plants of this Family unless they are quite certain what they are, for many are poisonous. Neither should they be fed to rabbits without proper knowledge. Hemlock is generally known to be poisonous, both the fresh green parts and the fruits containing a strong alkaloid which can be extracted as a yellowish juice with a mousy odour. Apparently it varies very greatly in strength in different plants. The plant, which is found in copses and woodland, is one of the largest members of the Family. It has large inflorescences, composed of about a dozen smaller umbels of white florets, each small umbel having three narrow bracts *all on one side*, while the whole inflorescence has a circle, or involucre, of narrow pointed bracts below it. The stems are smooth and spotted with dull brownish-purple blotches. The leaves are broad and fern-like, being divided into narrow segments, each tipped with a minute white point. The fruit is rounded and each half is marked with five thick vertical, wavy ridges ; the two halves fit together by flat surfaces.

Beaked Parsley.—Height, $\frac{1}{2}$ -3 ft. The similarities and differences between the members of this Family may be well illustrated by comparing this and the preceding example. If the flowers alone were examined, very little difference could be seen. Both have small white flowers with the calyx and corolla attached above the level of the ovary. The corolla consists of five minute petals, those on the outside being slightly larger. A pair of styles projects from the tiny throat of the corolla. Both plants have very similar foliage. They differ in size, and beaked parsley has downy hairs on the lower part of the stem, which is not spotted. It has no bracts at the base of the umbel, but the subsidiary umbels have narrow bracts—not, however, all on one side.

A very similar plant to the beaked parsley is the common keck or cow

parsley. Both occur in May and June as wayside vegetation. Keck has no hairs on the stem and each compound umbel is opposite to a leaf, whereas in beaked parsley it is at the end of the stem.

The most certain distinction is between the fruits, however, for in beaked parsley the narrow, conical fruit has a definite beak, and is rough, whereas in keck the fruit is smooth, with only a very short beak. Beaked parsley is more characteristic of dry soil and sunny situations.

PLATE 26. FIGWORT FAMILY

The Figwort Family consists largely of plants with showy, brightly coloured flowers, with a small calyx formed by joined sepals, and petals joined to form a tube-shaped corolla. This is usually irregular, that is, the flower is not a circular cup or disc, but can only be divided equally into two halves by a line passing through the centre from back to front. In addition, the corolla is often shaped into special parts for the convenience of insects, such as a platform to stand on, or a hood to protect the stamens from wind and rain. There are two or four stamens. The parts of the flower are set on to the stalk below the pistil, as in the Buttercup Family. The ovary (or lower part of the pistil, containing the unripe seeds) has two compartments. If a ripening fruit of a fairly large flower, such as the snapdragon, is cut through, it can be seen that the seeds are attached to a thick rod which passes down the middle. This point clearly distinguishes the Figwort Family from the Dead Nettle Family, in which four nutlets can be seen.

Most of the plants in this Family are herbs ; many are perennial.

Yellow Rattle.—Height, 2–8 in. This rather stiffly-growing plant is found in poor pastures and dry heaths. The yellow flowers are set at short intervals up the stem, the youngest at the top, and below them grow pairs of pointed, toothed leaves. Each flower has the lower part of the tube enclosed in a swollen, pale green calyx ; the upper part opens out into a lip or platform below and a hood, covering the stamens, above.

The roots of yellow rattle have an interesting way of obtaining extra food, since the poor soil which it favours does not provide enough. The roots can pierce their way into the roots of the grass amongst which they live and, growing into them, obtain nourishment which the grass has managed to obtain for its own needs. This, of course, so impoverishes the grass, that farmers do not welcome yellow rattle in their pastures.

Ivy-leaved Toadflax.—This is a delicate-looking little plant, yet really hardy, for it lives on walls and rocks, obtaining water and food from the scanty supplies stored in crevices. Its long, slender stems trail down

from where it is rooted, pressing against the stone background, while its ivy-shaped leaves face the light. Each tiny flower grows daintily on a separate stalk. It spreads its bluish-mauve petals wide to form an alighting ground for insects, which visit it for the nectar concealed in the dark purplish-red spur which projects backwards from the stalk.

Ivy-leaved toadflax actually sets its own seeds, for when the flower has fallen and the tiny round fruit is ripening, the fruit-stalk begins to turn away from the light and feel its way along the wall until it finds a small crack. Into this it grows, pushing the fruit in ahead. The fruit bursts open and the minute seeds are safely deposited in the crack, where there is probably enough soil and water to give them a safe resting-place and, later, a start in life.

Eyebright.—Height, 1–10 in. This is another little plant which, like yellow rattle, lives on poor soil in pastures, heaths and moorland. It is a low-growing annual, not unlike thyme in appearance, but its leaves and flowers are a little larger, and the leaves are toothed. The flowers are white or very pale mauve, delicately veined with purple or crimson. The root is small, only spreading an inch or two. It flowers from May onwards till late autumn.

Germander Speedwell.—Height, 6–20 in. There are many speedwells, or veronicas, all having very small blue, purple, or almost white flowers. Germander speedwell is one of the commonest of the blue ones, growing on hedge banks amongst grass, or as a weed in gardens, and flowering in early summer. Its flowers are of a deep, true sky-blue. It can be distinguished from the field speedwell, which has a white lower petal, but it must be carefully examined to distinguish it from the common speedwell. There are four petals, and the flower is nearly circular or regular, but the back or top petal is larger, and the front or lower one is narrower than the side ones. The corolla falls off easily, and it can then be seen that the petals are joined in a short tube. The flowers are arranged in racemes, and these grow *in pairs* from the junction of a pair of leaves with the stem. In the common speedwell, the racemes grow *singly*. The slender, weak stems are supported by surrounding plants. In both plants the stems are hairy, but while in the common speedwell the hairs are all round, in germander speedwell they form two delicate fringes which can be seen by holding the stem up to the light.

Red Bartsia.—Height, 4–8 in. This plant, like yellow rattle and eye-bright, lives on poor, dry soil, on heaths and pastures. It is a dingy, pinkish-red and the small flowers grow in close racemes; each flower has a small hood and a wide-spreading lip. The leaves are narrow, pointed and toothed, like those of yellow rattle and not unlike germander speedwell, except that they are longer. It flowers from June onwards.

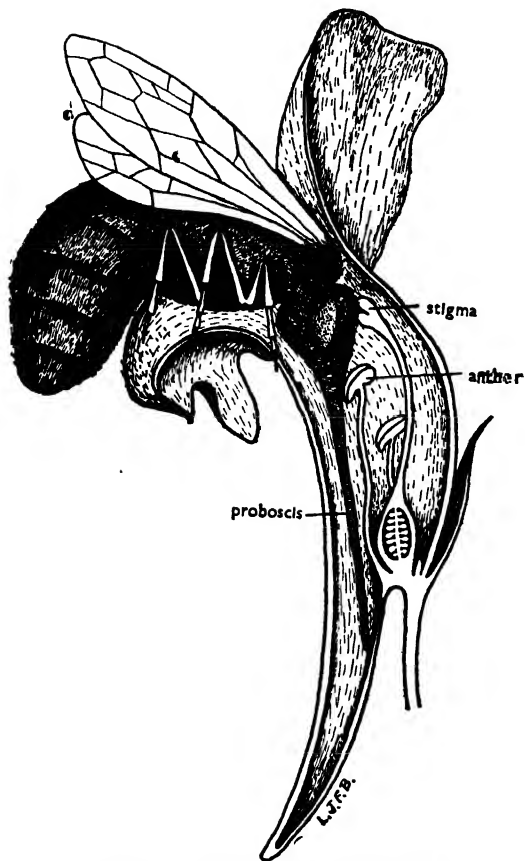


FIG. 24. Pollination of toadflax.

Yellow Toadflax.—

Height, 1–3 ft. This pretty plant is an early coloniser of newly-turned soil, railway cuttings or roads, and is also found on waste ground and as a weed in gardens and allotments. The stems are erect, and about 1 ft. is the average height, though this varies with the situation. The straight, narrow leaves are crowded densely up the stem, which bears a crowded raceme of yellow and orange flowers. Sometimes the stems branch and bear several racemes.

A bright orange spot attracts bees to the entrance of the flowers, showing them where they can push in their tongues for nectar. The tube is completely blocked by curiously-shaped petals and must be forced open, and, as the insect clutches

the lower petals and forces the throat open, its head touches the stamens hidden under a hood, and so becomes dusted with pollen. A long spur conceals the nectar.

Great Mullein.—Height, 2–4 ft. This large and handsome member of the Family is found in waste places, such as banks, gravel and chalk pits. It likes dry soil and is well protected against loss of water by a thick felt of white hair over leaves and stems, which gives the whole plant a grey appearance. It is a robust plant with a thick stem, bearing large, simple, pointed leaves and a long raceme of closely-packed, yellow flowers. It flowers in late summer, in sunny positions.

Foxglove.—Height, 2–4 ft. This vies with great mullein for the kingship of the Family, for under favourable conditions it is quite as tall, and even more striking in colour, with its deep purplish-red bells and dark green leaves, simple but slightly toothed. The spots and fine white

hairs in the mouth of the "glove" show very plainly on their light background, surrounded by the deep purple of the outside. They are supposed to point the way to the nectar, which lies in a slight swelling at the base of the flower. The stamens are protected by the hanging position of the bells. Bumble bees entering the flower are obliged to press the stamens to get past, and so release the pollen. It flowers from June to August.

Knotted Figwort.—Height, 1-2 ft. Here is another handsome plant, though its flowers are inconspicuous. The large, simple leaves are rounded at the tip and veined with red. The stalks are red. The flowers are brownish with a lip of a purplish-chocolate colour. The loose raceme is graceful and rather unusual, though not brightly coloured. The flowers are visited, and pollinated, by *wasps*, another unusual feature. It is said that wasps, unlike bees, pollinate a spray of flowers from the top *downwards*, but that bees go *upwards*. It will be noticed that the open flowers of the figwort are at different levels, not all at the bottom of the spray, as is usual. The figwort flowers in the late summer.

PLATE 27. ROSE FAMILY

Flowers of the Rose Family closely resemble those of the Buttercup Family in being, usually, regular and cup-shaped, with a calyx of five separate (free) sepals, a corolla of five free petals, and a large number of stamens with much pollen. They are different, however, in having sepals,

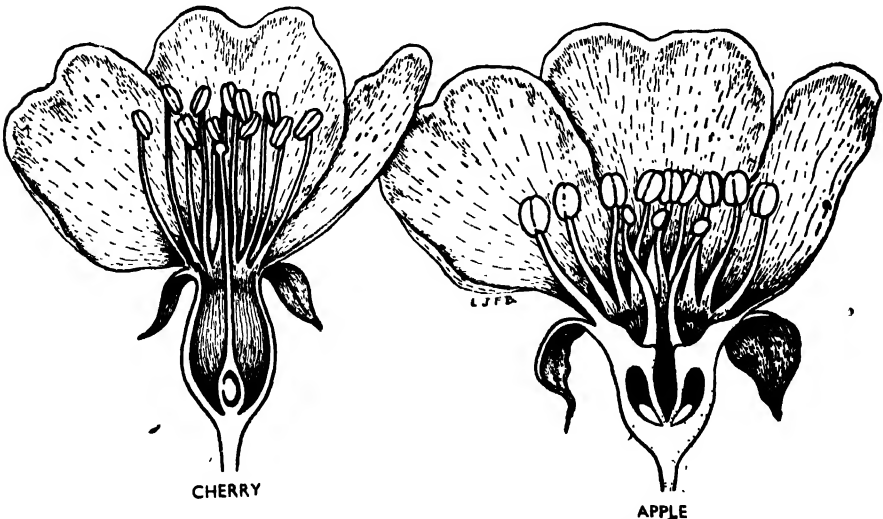


FIG. 25. Sections through cherry and apple flowers.

petals and stamens attached *around* the pistil not *below* it, in such a position that at least part of the ovary can be seen below them. Look, for example, at the dog rose on the Plate. In the picture of a section of a hip, it can be seen that the nutlets, or achenes, are enclosed in a bright red cup, called the receptacle, *at the top of which* the sepals, petals and stamens were attached. In the flower, this receptacle appears as a green oval structure below these parts. Agrimony and apple show a similar feature, while the other flowers pictured have a small part of the pistil sunk in a shallow receptacle, visible from the underside.

The Family includes many herbs, but also woody shrubs and trees. Most of them are perennial and some have creeping stems by which they reach fresh ground and establish new plants.

Many of the fruits are succulent and attractive to birds ; others are achenes.

Herb Bennet.—Height, 1-3 ft. This is a very common herb found by waysides, on banks, and in clearings of woods and copses. It is also known as geum and wood avens. Its small yellow flowers, which are shallow, five-pointed cups, appear from June to August. They are followed by fruits which are clusters of free achenes, each drawn out into a long stalk ending in a hook. These hooks catch in the coats of animals such as rabbits and sheep, which carry the fruits away and scatter them. The leaves, some coming from ground level and others from the stem, are deeply divided into lobes and toothed at the edge. Where they join the stem there are two much smaller segments, called stipules.

Wild Strawberry.—Height, 2-6 in. Flowering from May to July, this dainty little white flower is common on moist banks, in coppices and on the edges of woods or in clearings. The leaves are like those of the garden strawberry, but smaller. They have three rounded leaflets, deeply toothed and slightly pointed at the tips, meeting at one point. The flower-cups have five rounded petals well separated, the tips of the sepals appearing between them. There is also an epicalyx, formed of narrow lobes between the true sepals, so that there appear to be ten sepals. This is a very common flower pattern in the Family, with or without the epicalyx. Note that it is the same in every picture on the Plate, and especially notice the resemblance between strawberry and herb bennet, cinquefoil and silverweed.

The juicy scarlet fruit needs no description ; it is a miniature strawberry, very sweet and delicious in flavour.

Creeping stems, called runners, spread over the ground and root to form new plants.

Meadowsweet.—Height, 2-4 ft. This plant grows in ditches, marshy

places and beside streams. Its heavy fragrance scents the air when the creamy sprays of flowers open in June and July. The flowers are small, but arranged in loose racemes which are quite showy. Notice the long stamens. The flower-stalks are woody, the leaves dark green and deeply lobed, with small tufts between the larger ones giving them a fern-like appearance. Compare them with herb bennet and agrimony, for they are similar, though herb bennet has fewer lobes while agrimony has more and narrower leaflets. The small extra growths can be seen in all. "Queen of the meadow" is another name for this plant.

Bramble.—This is a climbing shrub, which grows to a tremendous size, flinging its long, hooked stems over hedges or along the ground. It is also called blackberry, from its fruits. The flowers are shallow pink or white cups of the usual Rose Family pattern, the petals are round and well separated. When the petals fall, the shallow saucer-like receptacle can be clearly seen with the remaining sepals and many stamens on its rim. Slightly sunk in this is the pistil, consisting of many separate parts which ripen into the juicy black fruitlets, each of which contains a seed. Each leaf has three leaflets of almost the same pattern as the strawberry, but separated by short stalks.

Birds enjoy the fruits and by eating them scatter the seeds, but the plants also spread by rooting the tips of the branches wherever they chance to touch the ground, often yards away from the parent plant. They have also underground creeping stems.

Dog Rose.—The delicate pink flowers of the dog rose cover our hedges in June. This is one of the largest flowers in the Family and it is from the simple cups of the wild roses that all our wonderful garden roses have been developed. The parts of the flower grow on the edge of the deeply-hollowed receptacle. The flowers grow in clusters spread along the ends of the branches. There is no nectar, but insects visit for pollen. The fruits are achenes, but the receptacle is bright scarlet and succulent, and so attracts birds which, by pecking at it, loosen and scatter these achenes and, therefore, the seeds inside them.

The plant may either stand alone as a shrub, or seek the support of other shrubs in a hedge, in which case the strong, thick stems may grow several yards long, hooking themselves on to the supporting plants by short, strong hooks. It spreads by short underground stems, called rootstocks.

Agrimony.—Height, $1\frac{1}{2}$ –2 ft. This plant, found on banks, especially where the underlying rock is chalk or limestone, has fern-like leaves and stiff spikes of small yellow flowers of the family pattern. The fruit is embedded in the receptacle, to the edge of which the flower parts are attached. As the fruit ripens and the other parts fade, the rim of the

receptacle becomes covered with tiny, incurved hooks. These become attached to the coats of animals and the whole receptacle, with its content of seeds, is carried away.

Cinquefoil.—Length, 6–18 in. This small creeping plant is common on dry waysides and banks. The name means “five-leaf,” and describes its leaves, each of which consists of five toothed leaflets. Otherwise the plant is much like the wild strawberry, and it spreads in the same way by means of surface runners. The flowers are yellow, and borne on slender, frail stalks, and the fruits are achenes. The cinquefoil flowers from June to September.

Crab Apple.—Sometimes in April or May the eye may be caught by a splash of deep rose in a tall hedge or by the edge of a wood. Closer inspection reveals the lovely pink and white clusters of the wild apple, or crab apple. The flowers of a cluster are arranged in umbels, that is, their stalks all arise from the same point. Each flower is a shallow cup, sepals, petals and stamens all growing on the edge of the green receptacle which is destined to become the edible part of the apple. This is not particularly acceptable to human beings, for the reddish-green apple is hard, sour and bitter. There are, however, cultivated crabs, such as the Siberian crab shown in the Plate, which have quite a pleasant, tart flavour. Siberian crab apples, which look like white heart cherries, make excellent jelly.

The crab apple tree may grow to a height of 20 ft., and the branches and twigs are usually rather notched and twisted. The bark is a very dark grey—almost black.

Silverweed.—Length, 3–12 in. This plant is found in much the same places as its close relation, cinquefoil. Silverweed differs from it chiefly in the leaves. The leaves of silverweed are fern-like and covered by fine, silky grey hairs which give them the appearance of being coated with a silver film. Most people would find it difficult to be certain of the difference between the flowers. Silverweed flowers are perhaps a little larger. Both plants spread in the same way by means of surface runners, as does the wild strawberry.

PLATE 28. MINT FAMILY

The Mint Family closely resembles the Figwort Family, both in the general nature of the plants, which are chiefly herbs, and in the appearance of the flowers. The plants of the Mint Family, however, have square stems, a useful point for which to look in distinguishing them. The calyx is a small cup with five points, and the corolla is united into a tube, spreading out at the free end to form a lip or platform, and a hood. The

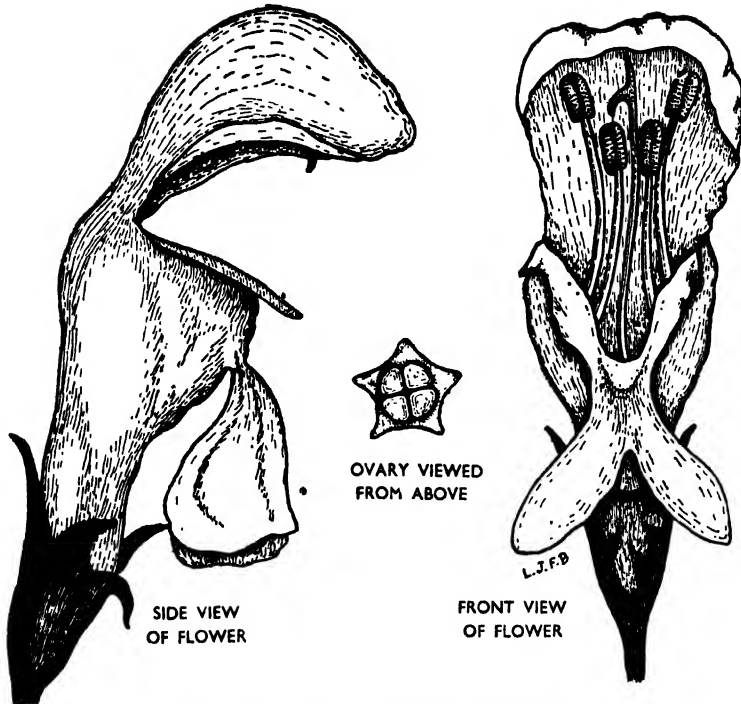


FIG. 26. Flower of white deadnettle.

four stamens are pressed against the back of the tube with the forked style between them, and in most cases the hood protects them.

So far they closely resemble the Figwort Family, but inside the calyx after the flower-tube has fallen, four nutlets can be seen. The ovary has actually two chambers, but each is deeply divided so that there appear to be four. There are four seeds. In this respect the flowers differ from the figwort type, in which there are two chambers with many seeds attached to a central rod, or column.

Many of the plants contain volatile oils which give them their characteristic smell, such as lavender, mint, thyme, sage; in fact, a great number of our culinary herbs. In others the smell is too strong to be pleasant. The leaves are in pairs, each pair at right angles to the ones above and below. Many are perennials with creeping rootstocks.

Red Dead Nettle.—Height, 4–18 in. This cheerful crimson flower can be seen in mild situations almost all the year round, and has a normal flowering period from April to October. It is a wayside plant found under the shelter of banks and hedges amongst grass, and is also a frequent

weed of allotments and the edges of cultivated fields. It is an annual. The leaves are more or less heart-shaped, with the edges cut into rounded teeth (*crenate*). The lower ones are as broad as long, about $\frac{3}{4}$ –1 in. across, and have long stalks. The upper ones, which bear flowers in their axils, have very short stalks and are smaller and more pointed.

The corolla is longer than the calyx and there is a well-marked hood and two-lobed lip. The flowers, crowded at the top of the main stalk, are clustered in apparent circles or whorls, but, actually, there are short branches in the axil of each flower-bearing leaf, each ending in one flower and having several others below it. This is the usual arrangement throughout the Family. The large leafy bracts are very characteristic of the dead nettles, and will be noted again in another of them, archangel.

Self-heal.—Height, 4–12 in. This perky herb, known also by the pretty Latinised name of *prunella*, reminds us by its popular name of one of the original reasons for man's interest in plants. Nearly all wild plants were accredited with medicinal properties, many of which have been disproved since scientific investigation has increased our knowledge of their chemical make-up. Self-heal is common in pasture fields. There is a tinge of bronze about the plants which stand stiffly with their short stalks and crowded heads of purple flowers, separated by short purple and green bracts. The paired leaves are narrow, oval and smooth, and one pair projects immediately below the dense whorled spike of flowers. Generally, the plant is low growing and the leaves are crowded together, but in favourable conditions, such as the long grass of a bank, they grow taller, as shown in the Plate. Where the growth is squat the leaves are frequently rounded instead of elongated. The plant is rather hairy. It flowers from July to September.

Water Mint.—Height, 1–4 ft. The strong scent of this plant advertises its presence in a ditch or by a riverside, where it usually grows luxuriantly in a tangled, spreading mass, established by means of creeping rootstocks. The whole plant is hairy with pale greyish-green, downy leaves and limp stems. The leaves are short, ovate (egg-shaped) and crenate, with short stalks. The stem may branch several times. Crowded whorls of pale lavender flowers appear from July to October.

Yellow Archangel.—Height, 6–18 in. This beautiful woodland plant flowers in May and June. Its single tall stalk bears many pairs of long, narrow ovate leaves, pointed and toothed, and the upper half-dozen pairs or so support the whorls of golden yellow flowers. Each whorl is well separated from the next, thus the striking display can readily be seen by insects. Six or seven flowers raise their long, shapely hoods back to back in a circle, while the large, three-lobed lips hang down, showing

orange veining to act as honey-guides. Insects which alight on the lip of a flower brush against the four anthers under the hood, thus removing pollen. If the pollen has already been shed, the forked stigma curves forward to touch the insects' head and back, thus receiving pollen from another flower.

Skullcap.—Height, 6–18 in. This slender, delicate-looking plant has the charm of unusual form. It grows by riversides but is by no means one of our commonest plants. The flowers, found from July to September, are borne in pairs on the upper part of the stem. They are well separated and stand out horizontally or slightly drooping from the axils of the narrow, paired leaves. The leaves, borne on short stalks, form long, narrow triangles, broadest and indented at the base, with crenate edges.

The flowers are deep, purplish-blue, with a very small, downy calyx and a long corolla-tube with small lips.

Marjoram.—Height, 1–2 ft. This erect, slightly woody herb is found in calcareous pastures and on banks, and its dry stems and the empty, woody husks of the fruits persist and add a touch of rich golden brown through the winter. The colouring is rich at all times. The leaves are deep green, the flower buds dark purplish-crimson, and the expanded flower-heads form flattish or slightly dome-shaped branching masses of puce-coloured flowers. The individual flowers are small, the stamens outstanding beyond the short lips. The main stem is tinged with red and bears on short stalks the small, smooth, ovate leaves well away from it at a wide angle. The flowers at the top of the main stem open first, followed by smaller heads borne on lower branches. The plant flowers from July to September.

Bugle.—Height, 4–12 in. Like most woodland flowers, the bugle is found in open spaces on the floor of damp woodlands, before the main undergrowth gains headway. It blooms in late spring or early summer—May to July—and will be found amongst such company as archangel, dog violets, ground ivy and bluebells. It might at first sight be taken for a dead nettle, for its upright stems bear similar whorls of flowers in the axils of the short, ovate leaves. On closer examination, however, it will be seen that the hood is represented only by a very short upper lip, while the lower lip is wide-spreading. The bract of the flower above protects the projecting anthers and stigma. The stigmas mature before the anthers. The leaves are smooth and ovate. Those on the stem are stalkless. There is a creeping rootstock. Although the plant appears very robust in its native wood, it droops rapidly if gathered, for the skin of the leaves and stems is very thin. This is the case with most woodland plants

where there is no lack of water, for the water current must be kept coursing through the stem by means of rapid surface evaporation.

Ground Ivy.—Height, 6–18 in. This plant has at a glance a considerable resemblance to the bugle, but on closer examination shows clear differences. To begin with, ground ivy has straggling, limp stems which lean on other plants or creep along the ground. All its leaves are stalked whereas those of bugle are stalkless. Though similar in size, they are kidney-shaped and crenate. The flowers are arranged in a similar way, in whorls of about half-a-dozen in the axils of the upper leaves. In ground ivy, the flowers are stalked and the joints or nodes are farther apart, thus the general effect is looser.

The flowers are more violet than blue, the middle segment of the three-lobed lower lip is broader than in bugle. The creeping stems of ground ivy root at intervals at the nodes, thus establishing the plant extensively. It has a wider range of habitat than bugle, for it is found on damp, shady banks and ditch sides, under hedges, and in woodland. It may be worth noting here that many of our hedgerow plants are thought to be relics of the much more extensive woodlands of former times. It will frequently be noticed that the same plants are found in both types of situation.

Hedge Woundwort.—Height, 1–3 ft. This erect, rather handsome plant is seen flowering in hedges in late summer. With its widely-spaced, nettle-like leaves it suggests the dead nettle, but the leaves are stalked and the spike of crimson flowers is quite different, for the whorls are marked only by short, narrow green bracts instead of by large foliage leaves. The flowers have a well-marked, three-lobed lip, white with crimson markings and border, and the tube and small hood are crimson.

It is interesting to notice the successive flowering periods of the members of this Family, and it is some help in recognising and fixing them in the memory, to associate each flower with its own flowering period and situation. Thus, ground ivy and the red and white dead nettles are first seen in the spring; bugle and archangel a little later; marjoram and woundwort in late summer. Blue and purple or crimson-purple predominate; yellow is unusual.

PLATE 29. WALLFLOWER AND PRIMROSE FAMILIES

WALLFLOWER FAMILY

The Wallflower Family is characterised by having the four petals arranged in the form of a cross, hence its scientific name of *Cruciferae*, the Cross-bearers. The short, narrow flower-tube is held by a claw-like

calyx of four free sepals, then spreads out flat above this, usually having a rather showy appearance. The petals are free, and either white or gaily coloured, yellow and pinkish-mauve being the commonest colours. Sometimes (as in garden wallflowers) the sepals are tinged with the same colouring as the petals. There are four free stamens attached to the receptacle below the ovary. A peculiarity of the Family is that the ovary is divided into two compartments by a plate down the middle, called a *replum*. The ovules lie against this plate, being projected inwards from the edge of each of the two carpels which form the ovary. The pods split by two valves to scatter the seeds. The inflorescences are racemose with a flat top.

Charlock.—Height, 1-2 ft. This bright yellow weed of cultivated ground is an annual, flowering from June to August and frequently occurring in such quantities that the whole field is one glowing golden sheet. It belongs to the same genus as the garden cabbage, which has a similar, though larger and paler, flower. Its leaves are oval or lyre-shaped, bright green and rough, differing from those of the white mustard and the black mustard. As the three plants are found in similar situations, it is perhaps worth while to tabulate their main differences.

CHARLOCK	BLACK MUSTARD	WHITE MUSTARD
<i>Leaves</i> lyre-shaped, and boldly toothed.	<i>Upper leaves</i> narrow, or linear.	<i>Leaves</i> indented in a pinnate manner.
<i>Pods</i> narrow, spreading, longer than beak, with three nerves in each valve.	<i>Pods</i> narrow, four-angled, with short beak, not containing seeds.	<i>Pods</i> narrow, spreading, hairy; valves five-nerved. Pod shorter than beak.
<i>Seeds</i> dark brown.	<i>Seeds</i> reddish-brown.	<i>Seeds</i> yellow.
River banks and waysides especially.		Whole plant hairy, with recurved hairs.

Jack-by-the-hedge.—Height, 2-3 ft. This tall, slender, biennial plant is usually found growing amongst the other plants of a hedge or ditch-bank. Its small white flowers are arranged in a long raceme, but only a few are open at one time, so that the flat head is not very conspicuous. After it has been blossoming for some time—and the flowering season is frequently long—the flowering head will surmount a number of long, narrow green pods arranged spirally below it, in various stages of development. The leaves are large, heart-shaped, and strongly veined, with toothed edges and long stalks. The whole plant smells strongly of garlic, especially when bruised. This accounts for the alternative name of *garlic mustard*.

Wild Wallflower.—Height, 6–15 in. This is not, strictly speaking, a native flower. It comes from Northern Europe, where it is a rock plant and has established itself freely on stone walls, especially on the walls of ruined castles, abbeys and other ancient buildings. Both plant and flower are smaller than the modern, cultivated wallflowers, and the wild flower does not show their gorgeous colour variations, yet the soft, tawny-yellow corollas, set off by the purplish and bronze calyces, are pleasing.

Like the cultivated plant, the wild one has narrow, smooth-edged leaves crowded up the stem, and a rather broad, rounded raceme. The fruits are in the form of long pods developing in the lower part while the upper part is yet in flower and bud. The petals are rounded, narrowing down to a slender claw of attachment. The two outer sepals are pouched at the base, to hold the nectaries, which are embedded in the cushion or receptacle. This is the usual condition throughout the Family.

The fruits of the wallflower are large enough to show very clearly the characteristic structure, the replum bearing the seeds and the two valves splitting away from it. This type of long, narrow pod with replum is called a *siliqua*. Fruits having the same type of structure, but broad instead of long, are called *siliculas*, as in honesty and shepherd's purse. The wallflower is biennial.

Shepherd's Purse.—Height, 6–18 in. This is a weed of gardens and waste places having a rosette of narrow, slightly or deeply indented leaves and a few small stem-leaves. The plant is slightly hairy. It has an inconspicuous inflorescence of small white flowers, of which only a few at the top are open at once, forming an almost flat head. Below these the fruit-stalks continue growing, each fine stalk bearing a heart-shaped pod with the narrow, pointed end joining the stalk (*obcordate*). It is these fruits, as they open, that give the plant its fanciful name. The shepherd's purse is an annual, or, rather, an ephemeral, since it produces several generations in one year.

Lady's Smock.—Height, about 9–24 in. This delicate lilac flower of the wet meadows, occurring with the kingcup in April, is perhaps one of the prettiest of the Family, with its wide, almost flat inflorescence of large-petalled flowers encircling unopened buds. The leaves are dainty, too, being pinnate with narrow, smooth-edged leaflets. The plant is perennial.

PRIMROSE FAMILY

The plants in the Primrose Family are herbs, mostly with radical leaves, circular flowers having petals united and sepals united, and attached

below the ovary. The stamens are attached to the corolla-tube. The ovary consists of one chamber with a central rod to which the ovules are attached (free central). The fruit is a capsule.

Primrose.—Height, 4–8 in. The pale green crinkled, radical leaves appear early in the year forming rosettes from the centre of which grow the yellow flowers which open in March and April. Though apparently growing singly, it will be found that the flower-stalks join at about the soil level. They actually branch from one very short common stem, thus having the same type of inflorescence as the cowslip and polyanthus. The five heart-shaped petals narrow and unite to form a tube which ensheathes the five stamens and pistil. This is enclosed by a pale, softly hairy, fluted calyx of five united petals. The ovary is spherical, and drawn out into a single style and knob-like stigma, and there are five stamens. A curious device which ensures cross-pollination is found in the primrose and the rest of the primulas. It consists of an inequality in the length of stamens and style which makes it difficult or impossible for the pollen to reach the stigma of its own flower. Two types of flower are found. In one case the stamens have long filaments, bringing the anthers just to the mouth of the corolla-tube; the style is short, so that the stigma is only about half-way up the tube. In the second type, the reverse is the case. It has been ascertained that, when a bee visits either type of flower in search of the nectar at the base of the tube, it touches with the same portion of its tongue the corresponding stamens and stigma. Thus, if pollen has been collected on the tongue, it is likely to be deposited on the stigma of another flower at the same level as the stamens from which it came. This interchange makes for the production of better seeds. There are further differences both in the size of the pollen-grains and in the nature of the stigmatic surface which receives pollen. When the stamens are long, the flower is called *thrum-eyed*, from the cluster or “thrum” in the “eye” of the flower; when the stigma is at the entrance it looks like a pin-head and so the flower is called *pin-eyed*.

In addition to producing seeds, the plant reproduces vegetatively by means of short rootstocks, so that a clump of primroses increases in size, that is, extends its area, each year. •

Yellow Loosetrife.—Height, 2–3 ft. This plant is found by river banks and in damp places. It is erect with broad, lance-shaped leaves either opposite or alternate. The edges are entire, the leaves without stalks, smooth or downy below, and masked above with black dots which are glands. The deep yellow bell-shaped flowers grow in small clusters, each cluster on a branching stalk, from the axils of the upper leaves and at the top of the stem. The edges of the calyx are red and hairy; the

centre of the corolla is marked with orange spots which, as in so many flowers, serve as honey-guides. The stamens unite into a tube at the base. The flowers appear from June to August.

Cowslip.—Height, 4–12 in. The flowers are found in damp, clayey meadows and ditch banks in May. The leaves resemble primrose leaves, but are perhaps less crinkled and rather larger when fully grown. The growth is much like that of the primrose, the flower-stalks coming from the centre of the leaf rosette, but the inflorescence consists of numerous flowers on very short stalks springing from the top of a long, light green, main stalk. The flowers are funnel-shaped with a small five-pointed cup marked inside with five orange spots. As in the primrose, they are pin-eyed and thrum-eyed. The tube of the thrum-eyed flower widens out just below the cup to accommodate the anthers. Stalks and calyces are mealy and very pale green. There is a creeping rootstock.

Scarlet Pimpernel.—This little plant trails along the ground between the stalks or stubble of cornfields, its square stem sending up short, slender branches at intervals. It has oval, smooth leaves in pairs, with entire edges and no stalks. The flowers, about $\frac{1}{2}$ in. in diameter, are borne singly in the leaf axils on very fine, long stalks. They are circular and almost flat, with five united petals having rounded lobes and five narrow, pointed sepals. The ovary has five sections but, unlike most of the Family, instead of splitting by five teeth at the apex, it forms a small cap or lid which separates from the rest like the lid of a circular box. From its habit of closing its flowers in damp weather the pimpernel is also given the name of “poor man’s weather glass.” It is an annual.

PLATE 30. PEA FAMILY

The Pea Family consists of herbs and shrubs, some annual, some perennial, with gaily coloured, irregular flowers, either single or gathered into racemes or close heads. Predominating colours are yellow, red and purple. The sepals are free. The five petals are free, but folded together to form a tube round the stamens. The two lower petals form a keel, the upper one in most cases spreads out to form a showy standard, while the side ones form wings. The ten stamens form a narrow tube surrounding the pistil, nine being joined together and one free, or all ten joined. An insect visiting the flower to obtain nectar—and this is an important honey-producing Family—has to force its tongue to the base of the tube, and in order to do so, grasps the keel with its feet and presses it down. This forces the stamens and stigma against the insect’s head or body, when pollen is either dusted on to the insect or taken from the insect on to the

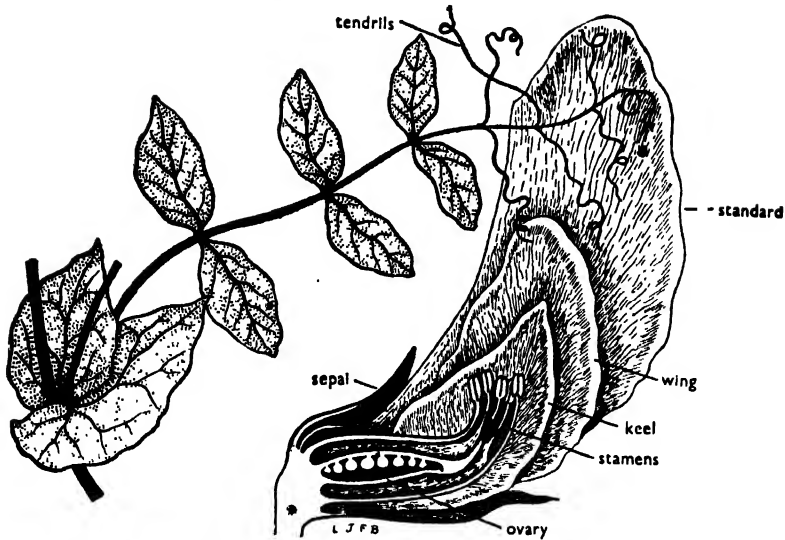


FIG. 27. Leaf and flower, in section, of pea.

stigma. In most cases, when the insect lets go, the stamens and stigma return to their enclosed position inside the keel.

The fruit is a pod or legume, that is, a splitting dry fruit, opening by two long slits at the edges and midrib of the single seed-bearing leaf, or carpel, which forms the pistil.

The leaves generally consist of several smooth leaflets, either three, as in clover, or a larger unequal number forming a feather-shaped or pinnate leaf. Where they join the stem there is a pair of leafy outgrowths called stipules. A number of plants climb by means of tendrils, which are leaflets reduced to a hair-like process, sensitive at the tip to contact, and responding just behind the tip by turning round the object touched, if it is sufficiently thin.

A point of great interest is a peculiarity of the roots in all members of this Family. At an early stage the roots become infected by certain bacteria inhabiting soil. These multiply, forming small swellings called *nodules*. The bacteria are capable of taking nitrogen from the atmosphere, and converting it into nitrates, which are essential plant food. The nitrates are produced in such excess of the needs of the bacteria, that not only are they sufficient for the needs of the "host" plant, but quantities are deposited in the soil, becoming available for subsequent crops. Hence, leguminous crops enrich the nitrate content of the soil.

Kidney Vetch.—Height, 4-16 in. This is found on dry pastures and heaths, and flowers from June to September. The pale yellow flowers are closely crowded in a head at the top of a single slender stalk, bearing pinnate leaves with narrow leaflets. Immediately under the head are two large, much-divided bracts. Leaves, bracts and stalks are covered with fine silky down, giving the plant a greyish tinge. The name is said to be due to the supposed resemblance of the paired flowers to the two halves of a kidney. Another name is "lady's fingers."

Red Clover.—Height, 3-18 in. This common plant of waysides is a useful fodder crop, and is also valuable for enriching the soil with nitrates. It flowers from May to September and is visited by bumble bees for its honey. The purplish-red flowers form a compact, rounded head or *capitulum*, with deeply-divided bracts. After pollination the flowers turn downwards, thus showing which members of a head have no more nectar to give.

The foliage leaves are of the trefoil, or three-leaf type, some of them radical and some growing on the flower-stalk. It is a perennial.

Tall Melilot.—Height, 2-3 ft. This herb of waste ground, which is also a garden weed, may be recognised by its long, narrow spiky inflorescences and pointed, trefoil-shaped leaves. The inflorescence tapers to a point, and the individual flowers are small and close to the stalk, with equal petals. The pod is hairy. The yellow flowers occur from June to August.

Broom.—Height, 1-6 ft. This is a rapidly-growing shrub with woody stems which produces many new green shoots each year. It has small ternate (three-leaflet) leaves, and showy yellow flowers, butterfly-like or papilionaceous, in May and June.

Bees visit the flowers, receiving a shower of pollen as they tear open the petals, releasing the stamens and long coiled styles. Unlike most flowers of the Family, the keel does not spring back, but the stamens and styles remain exposed, warning insects that a further visit is useless. Indeed, there is no nectar, so that a little pollen is the only food an insect receives, and this is all shed in the single explosion. As the ripe pods split open, the two valves twist, thus forcing out the seeds.

Bird's-Foot Trefoil.—Height, 4-18 in. This dainty little flower of waysides and pastures creeps along the ground, leaning for support on grasses and other low plants, but not taking any hold. Its leaves are ternate and form a close, green foliage amongst which the deep yellow flowers nestle. These are often tinged with orange or scarlet. The flowers radiate from one point at the top of the stem, forming a simple *umbel*. They are papilionaceous. The plant is common, and the flowers are seen from July to September.

Furze.—Height, 2–6 ft. This prickly shrub, also called gorse and whin, flowers from February onwards and scattered flowers may be found almost all the year round. Both this and broom like sandy or gravelly soil. Furze is found on dry heaths and sandy banks. The seedlings have three leaflets which are tender and liable to be eaten by grazing animals, but the prickly branches and reduced, prickly leaves of the plant as it grows older effectively prevent this. The hard, prickly character is, however, probably connected chiefly with preventing loss of water.

The showy yellow flowers resemble those of broom, but are more densely packed. The short, broad pods open with a sudden explosion, which causes the seeds to shoot out to some distance. On a warm August day the popping of the pods can frequently be heard.

Spiny Rest-Harrow.—Height, 6–18 in. This plant is found in rough pasture land and waysides, and bears some resemblance to broom and furze. It is smaller and less bushy than either, yet it seems to combine characteristics of both, for it has many small ternate leaves, mingled with sharp spines. It has a dusty, almost draggled appearance, but is attractive when in flower in late summer, since its broom-like flowers are bright rose pink.

Needle-Whin.—Height, 1–2 ft. This miniature shrub, also called petty-whin, grows on heaths, but it is not common. It resembles both broom and furze in having small, narrow leaves and, like the furze, it has spines. These are fine and needle-like and grow up to 1 in. long. The yellow flowers grow singly in the axils of leaves, like furze and broom, and the pods resemble those of furze, except that they are smooth. The word “petty” in petty whin comes from the Norman-French: “petit” meaning “small.”

Sainfoin.—This is a cultivated fodder crop in this country, not native, though stray specimens from the cultivated fields may establish themselves. It has dense cone-shaped racemes of handsome, rose-coloured flowers, and long pinnate leaves. Each plant has one long slender stalk bearing a raceme. The flowers are papilionaceous, and occur in June and July. It flourishes on calcareous soil.

PLATE 31. DAISY FAMILY—I

With the exception of the Grasses, this is the most widely spread and most successful of all flower families. Many of its members, such as the daisy and dandelion, will, if left to themselves, populate large areas to the exclusion of most other plants. They have two chief means of bringing this about; firstly, by means of underground stems producing buds from

which new plants grow ; secondly, by means of very light dry fruits, each enclosing one seed, and frequently provided with a light, feathery circlet of hairs called a *pappus*.

Individual flowers are small, but they are invariably gathered together in a tightly packed head or *capitulum* of many florets. This composite flower looks at first sight like a single flower, and gives the Family its scientific name of *Compositæ*. Yellow and white are the predominating colours. Two types of floret occur, but both are not necessarily present in every member of the Family. There are tubular florets formed of five joined petals ending in five small free points; and strap-shaped or ligular florets consisting of a very short tube with the petals drawn out into a long, narrow projection. Sepals are reduced to hairs. The capitulum is usually disc-shape but may be more or less globular, and it is held together by the bracts which are arranged in a ring or in several overlapping rows below it; forming what is called an *involucre*.

Sleep movements, in which the whole inflorescence takes part, are common either at night or in cold, cloudy or wet weather.

Corn Chamomile.—Height, 6–24 in. This plant is a weed of corn-fields, cultivated ground and waste places. In a general way it resembles the ox-eye daisy, having yellow disc florets and white ray florets, but it differs in the following ways :

(1) The plant is slightly branched while the ox-eye daisy rarely has more than one head of flowers on a stem, though occasionally two or three may be found.

(2) There is a tendency of the ray florets to turn downwards, and the disc is more rounded, cushion-like, and proportionately larger.

(3) It has complex pinnate leaves of a feathery or fern-like appearance and hoary texture. These are borne on the flower-stalks as well as at ground level.

(4) There is a slight smell of chamomile.

(Note : The so-called *seeds* of all the Daisy Family are really *fruits* of individual florets, the single seed being enclosed in a closely adherent fruit wall, as in the Grasses. In the corn chamomile, ox-eye daisy and scentless mayweed, another flower resembling these two, the fruit has *no* hairy plume or pappus to help in dispersal.)

Hemp Agrimony.—Height, 2–4 ft. This handsome plant is found in moist woods and by the banks of rivers and ponds. Its large leaves are divided into three to five long, narrow leaflets toothed at the edge and with long points. The flower-heads are in dense, flat clusters called *corymbs*. They are purplish-pink. Each flower-head is small and narrow with short outer bracts, consisting of only five or six tubular florets with

long, projecting branched styles. The stems are downy, woody at the base and only branching near the top, giving the plant, which is perennial, a bushy appearance. It is dispersed by small, plumed fruits.

Scentless Mayweed.—Height, 1-2 ft. This differs from corn chamomile chiefly in its more bushy appearance and in the character of the leaves. These are divided into narrow linear segments, feathery or mossy in character, clothing the lower part of the flower-stalks with a "fuzzy" mass. It has no smell, and is usually of a low, squat growth. It is found in similar places to the corn chamomile.

Daisy.—Height, 2-5 in. This highly successful little plant is found in pastures, lawns and wayside turfs. It establishes itself by means of light, nut-like fruitlets and short rootstocks which spring from buds at the surface of the ground. These unfold, while the spreading rosettes of radical leaves edge other plants out of the way by keeping the light from them. At the same time short, sturdy roots are striking downwards. This modest little flower of the poets has thus an extremely efficient, though simple, mechanism for establishing itself firmly and taking possession, as everyone knows who has tried to keep a lawn free from its invasions. The name is said to mean "day's-eye," from the habit of opening with early morning sunshine—the "eye of day."

Fleabane.—Height, 1-2 ft. This plant is common in wet places, flowering from July to September. It is of the marigold type, with yellow disc and ray florets, and leafy, downy stems. The leaves are softly downy, an elongated heart-shape, partly wrapped round the stem at the base, and toothed.

The plant grows in rushy places or beside slow boggy streams amongst ragged robin, wild mint and forget-me-not. The name indicates that by the old herbalists, who attributed one or more useful properties to practically every wild plant, the fleabane was regarded as efficacious against fleas, which fled from the smoke caused by burning it. Incidentally when less hygienic habits made the air in rooms noisome, it was a common practice to counteract the smell by burning herbs on a shovel or small brazier. A decoction of fleabane was also valued as a remedy for dysentery.

Ploughman's Spikenard.—Height, 2-5 ft. This is a tall but inconspicuous plant. The large, oval leaves are dull in colour and the flower-heads, in crowded corymbs, are of a pale yellow with the thread-like florets scarcely showing above the long involucre of green, scaly bracts. These bracts are in overlapping rows, with the lowest turning outwards at the tip. The flower-heads are about $\frac{3}{4}$ in. across. The stems are leafy, with narrow, elongated leaves at the points of branching. The fruit is plumed. The plant grows on calcareous soil and in copses and woods.

Ox-eye Daisy.—Height, up to 2 ft. This plant is found in meadows, roadsides and railway embankments. The flower-heads are borne separately on a long stalk or on stalks which branch only once or twice. There are narrow, leafy bracts on the flower-stalks. The radical leaves are dark green above, paler below, and slightly lobed or indented. Each flower-head, about 2 in. in diameter, consists of a small yellow disc and long white, strap-shaped ray florets. The centre is flat and compact, the tubular florets are very short. There is no tendency for the rays to turn backwards, as in the mayweeds and chamomiles.

Blue Fleabane.—Height, 9-18 in. This plant grows in dry places, especially calcareous pastures. It belongs to a different genus from the common fleabane previously described, though no doubt it had a similar use. The Daisy Family contains a very large number of aromatic plants, many of which seem to have been popular remedies for the various "ills that flesh is heir to."

Blue fleabane has many branching stems with numerous narrow leafy bracts and small heads. The ray florets are purplish—not blue—while the small disc is pale yellow; the florets stand upright and are not conspicuous. The pappus which succeeds the florets is reddish and the stalks also have a reddish tinge. The radical leaves are simple and narrow.

Yarrow.—Height, 6-24 in. This common herb of wayside and pasture is also aromatic, having a sharp, fresh smell so strong as to cause sneezing, as does its close relation, sneezewort. The leaves must be familiar to everyone; they are long, narrow, and deeply divided into linear leaflets which are again twice divided, the effect being feather-like. The small heads of florets, in crowded flat corymbs, are either white or slightly tinged with pink or purple. There are both ray and disc florets. The plant is still used as a flavouring, especially in home-brewed beers, with nettles, dandelions and other herbs.

PLATE 32. DAISY FAMILY—II

* **Spear Thistle.**—Height, 2-5 ft. This bold, handsome plant flowers in July and August, producing heads of deep purple tubular flowers, 1 in. or more across, tightly held together by an egg-shaped involucre of many rows of prickly bracts. The spear-like leaves end in sharp, hard points and the stem also bears sharp prickles, so that the whole plant is formidably armed. After flowering, numerous achenes develop, each bearing a pappus of long white hairs, a special adaptation of the calyx. On this the fruit floats away until it drops of its own weight, while the plume sails

on, the well-known thistledown. The plant is found chiefly in waste places, edges of fields and waysides.

Coltsfoot.—Height, 4–10 in. One of our earliest spring flowers, coltsfoot flourishes in damp places on heavy clay soil. It may be found on waste ground, railway cuttings, and sometimes as a garden weed. Its attractive, fresh yellow flowers appear before the leaves. The flower-stalks are studded with small leafy bracts, and the buds are enclosed by long bracts which open to reveal a yellow flower having a central disc of tubular florets surrounded by rays formed of ligular florets. The tubular disc florets produce only stamens, while seeds ripen only from the ray florets. Each disc floret, however, has a sterile pistil with a brush-like stigma, which acts much like a chimney-sweep's brush. It pushes upwards through the tube, forcing out the pollen which has been shed into it. This flower has marked sleep movements.

Coltsfoot leaves are large and shield-shaped, with five points. They are slightly toothed. At first they are curled and covered on both sides with fine grey hair, but the upper surface sheds the hairs, which form a web, the leaves soon after unfolding. The hairs possibly serve the double purpose of preventing the leaves from getting either too wet or too dry.

The plant sends a thick, white creeping stem, covered with small scaly leaves, under the ground. It forms new plants at intervals and on this account is difficult to eradicate as a garden weed.

Chicory.—Height, 1–3 ft. This lovely, pure blue flower is found in late summer by waysides and in waste places, especially on chalk or limestone soils. The flower-heads, with ray florets and disc florets both strap-shaped, are more than 1 in. across and lie flat against the main stem on almost non-existent stalks. They are borne spirally along the whole length of the stem but only two or three open at a time, thus one or two faded ones below, and buds above, are characteristic. The stem is rough, ridged, slightly sticky and unusually tough, almost unbreakable.

The thick tap-root is roasted and ground for use in the making of coffee.

Nipplewort.—Height, 1–3 ft. This lanky plant has big, succulent, radical leaves with a large upper lobe, the lower part being deeply notched. The flowering-stalk is thin, wiry and much branched, bearing small, pale yellow heads of flowers (about $\frac{1}{2}$ in.) like miniature dandelions, with involucre of a few long narrow bracts. Leafy bracts grow at the junction of the main branches. After flowering, the stalks and involucre become dry and woody, persisting late into the autumn, long after the seeds are shed. The plant is characteristic of shady banks, sides of ditches and damp waysides.

Ragwort.—Height, 1–4 ft. This robust vulgarian has a certain charm when seen in glowing masses amongst coarse wayside herbage, but the individual plants, apart from their rich colour, have little to attract admiration. Their deeply-lobed or pinnatifid leaves clothe the whole flowering-stalks, and the separate heads have too large a central disc, too short and too widely-spaced rays, to be attractive. They are of the daisy type, but with less beautiful proportion. Numbers of loosely-spaced inflorescences grow from one many-branched flower-stalk. It is an obvious cousin of groundsel.

Hard-head or Knapweed.—Height, 1–3 ft. This is a striking plant, with an erect flowering-stalk rising from amongst large pinnate radical leaves. The large oval buds are enclosed by many layers of small fringed bracts, purplish-green in colour and overlapping like fish scales. The reddish-purple inflorescence consists of a disc of tubular florets surrounded by much larger ones occupying the usual position of rays. Each of these has five well-marked petals spreading in a star, as in a cornflower, giving the head a conspicuous appearance. These outer tubular florets are sterile, merely serving to attract the attention of insects which visit the disc florets and so bring about pollination. The achenes are surmounted by stiff bristles arranged in a circlet. These are not light enough to bring about wind dispersal. The hard-head flowers from July to September in cultivated fields and waste ground. It is also known as great knapweed.

Cat's Ear.—Height, 6–18 in. This rather dandelion-like plant takes its name from the small pointed bracts on the stalk. The radical leaves resemble those of a dandelion, and the yellow inflorescences consist entirely of ligular florets. It differs from dandelion, however, in having no milk or latex. The flowers and leaves are smaller; the stem longer, thinner, and neither so smooth nor so succulent. The stem may be single or branched, each branch bearing one head of florets. The buds are pear-shaped and the bracts are in several rows. It is a common perennial in meadows, pastures and heaths, and flowers throughout the summer and autumn from June.

• **Carline Thistle.**—Height, 6–18 in. This curious plant reminds one of the everlasting flowers, for the inner circle of bracts is yellow, hard and scaly, and it will last almost indefinitely, giving the appearance of a yellow flower. The stem may branch several times, and each branch bears one inflorescence $\frac{3}{4}$ in. to $1\frac{1}{4}$ in. across. The florets are all tubular and are of a purplish colour, but as they are mixed with numerous yellow bristles, the general appearance is more yellow than purple. The stem is closely set with prickly and hairy leaves, deeply-toothed and ending in

sharp points, though not so formidable as in spear thistle. It is found on open pastures and downs, flowering from June to October.

Groundsel.—Height, 3–12 in. This common weed is an annual but produces such large numbers of plumed fruits that its succession is well assured. It may even produce several generations in one season. Such plants are sometimes distinguished from ordinary annuals by the name *ephemeral*. The stem and leaves are dull, dark green, slightly downy. The leaves are long and deeply indented. The flowers are in small yellow inflorescences in a cluster at the top of the flower-stalk. Each inflorescence is about $\frac{1}{4}$ in. across, and consists of tubular florets only.

PLATE 33. DAISY FAMILY—III

Tansy.—Height, 2–3 ft. This plant is found in dry, sunny places such as roadsides and the edges of cultivated fields or allotments. The green stem, clothed with finely-divided leaves, is erect and gives rise at the top to a number of branches bearing many crowded inflorescences in a more or less flat mass called a *corymb*. Each button-like inflorescence is about $\frac{1}{2}$ in. across and consists of tightly packed disc florets, and one outer ring of very short ray florets. These are pistillate; the disc florets are staminate. The leaves are pinnate and each long narrow segment is notched, the effect being fern-like. The flowers appear in late summer.

Cornflower.—Height, 1–2 ft. As the name suggests, this is a flower of the cornfields, blooming from June to September at about the height of the corn. It is a free-growing annual, often self-sown in gardens where the seeds have once been introduced. The bright, deep blue flower-head spreads out a circle of star-like tubular florets enclosing a small disc of smaller seed-producing florets. As in its cousin, the great knapweed, the outer florets are sterile and serve for attraction. The head is about 1 in. across. The florets are nipped in and held together by a small involucre of narrow, overlapping scales.

Dandelion.—Height, 4–12 in. This flaunting plant is perhaps the most successful member of the whole Family, at any rate in Britain. Its success is due to many features. The bright golden flower-head of ligular florets attracts insects, and after pollination each floret produces one seed enclosed in a hard case, the wall of the pistil. Even if no pollination takes place, it is found that the seeds will ripen—an unusual occurrence amongst flowers. From each calyx of delicate white hairs the familiar plume arises, pushed up on a long stalk. The “clock” serves to bear the seeds on the wind, thus dispersing them.

Sleep movements can be well observed in the dandelion. Like most members of this Family, the pollen is pushed up to the top of the tube (in this case very short) by the growth of the style. This brings the ripe pollen into an exposed position—an asset for ensuring pollination, but dangerous in wet weather. The habit of the whole inflorescence of closing in damp or cold weather and at night is useful in protecting the pollen from rain.

The milk or latex is a typical feature of the dandelion, and some other members of the Family, such as the wall lettuce.

The long taproot obtains an exceedingly firm hold of the ground, and is, as any gardener knows, extremely difficult to destroy. It is not only brittle so that it usually breaks unless very carefully dealt with, but bits left in the soil can produce buds from which new plants arise. Buds at the junction of stem and root form new rosette-shaped offsets.

Wall Lettuce.—Height, 1–3 ft. This plant occurs in chalky soil, in woods and on old walls, where mortar and deposits of soil hold sufficient water. The jagged leaves have somewhat the soft, crisp texture of cultivated lettuce, but have a strongly-marked brownish central vein or midrib. The leaf has a large triangular terminal lobe and two smaller lobes; the lower part is narrow, but widens a little at the base where it projects on each side to enclose the stem.

The small inflorescences are bright yellow and consist only of ligulate florets held by a slender involucre of a few narrow bracts. They form a much-branched, loose corymb. The ridged and slightly beaked fruits have a pappus resembling that of groundsel or thistle.

Corn Sow-Thistle.—Height, 3–4 ft. This luxuriant plant occurs as a weed in cornfields, is a perennial, and flowers in the autumn from August onwards. Its tawny-yellow flowers are large and handsome; the buds, enclosed by long narrow bracts, are swollen at the base and taper to a point. The stems are leafy; the leaves are of succulent, soft texture, but provided with sharp spines. The inflorescences are combined in a large, many-branched corymb. The base of each leaf clasps the stem. Radical leaves are also present.

• **Burdock.**—Height, 3–4 ft. Great burdock is a woodland plant with large, rounded lower leaves with a blunt apex. The flowers, which occur in July and August, are pink, and borne in thistle-like heads with a spiky involucre of narrow bracts. They are borne singly or in twos and threes on long stalks, forming a loose corymb. Below each inflorescence-stalk is a large, pointed leaf. After pollination the bracts harden and become incurved to form small hooks. The whole head loosens, and the hooks cause it to cling to the fur or wool of any passing animal. The bracts

then separate and the hard fruits fall out. This alternative to a plume seems to be a successful device.

Butterbur.—Height of flowering-stalk, 6–12 in. Height of leaves, up to 3 ft. This plant, found in wet, usually shady places, often occurs in large patches and is frequently mistaken for a wild form of rhubarb. The foliage leaves closely resemble those of rhubarb, though the stalks are green, more strongly ridged, and thinner. The flowers occur before the leaves, from March to May. They have a curious appearance, for each small, compact head is closely packed against its neighbours, forming a dense, short spike. The pink flowers are offset by the brownish or purplish bracts and livid stalk. Each inflorescence consists of tubular flowers which may be either all male or all female, though the male heads may contain a few female flowers, and the female heads a few male. The different kinds of flower are produced by different plants. As can be seen from the Plate, the female floret is tubular with a protruding style; the male floret has a mouth cut into five lobes. The thick, white stalk has a number of short greenish or pinkish bracts, gradually passing into the form of foliage leaves lower down the stem. Note in the picture the broad leaf-base and minute blade of the lowest one. The upper bracts consist only of leaf-bases.

Goat's Beard.—Height, 1–2 ft. This plant of the grassy wayside or permanent meadow is notable for its noonday sleep movement, which gives it its alternative name of "John-go-to-bed-at-noon." It is also noted for the strikingly handsome "clock," much like that of a dandelion, but larger and of a stiffer texture. The long rays, borne on slender stalks, are feathered with delicate bristles.

The yellow flower-head, about 1 in. across, is less conspicuous than a dandelion, but notable for the long pointed bracts of the involucre projecting beyond it. The stalk is slender and rigid, bearing only one inflorescence. The radical leaves resemble those of a dandelion but are less tender and dryer. The flower-stalk has several pointed bracts which enclose it at their bases.

Bristly Ox-tongue.—Height, 2–3 ft. This plant somewhat resembles the sow-thistles but can be distinguished by the less tapering buds, which are of a brighter green colour, by the less orange flowers, and by the shape of the leaves. These do bear a resemblance to an ox-tongue both in shape and texture though they are more pointed, and the minute tubercles of a tongue are represented by actual bristles arising from little swellings. Bristly ox-tongue flowers from June to October in hedges and shady roadsides or fields.

PLATE 34. MISCELLANEOUS FAMILIES—I

ROCK ROSE FAMILY

The Rock Roses, as their name implies, are always found in rocky places where the soil is shallow and, on the whole, rather dry. Many of them are alpine and of these there are several British species, having a scattered distribution. They are not very common. They have the characteristic hoariness associated with mountain plants.

The Family is grouped with the Buttercup, Rose, Poppy and Violet Families, and all the Families represented on the Plate, by the characteristics of free sepals, petals and stamens, and the attachment of parts of the flower *below* the pistil. In these respects, as well as in the prevalence of the simple circular cup-shape, these Families are more primitive than those in which the corolla forms a united tube, while in many cases the petals are peculiarly modified in connection with pollination.

Rock Rose.—Length, 3–10 in. The plant figured is the only common British rock rose. It is found on chalky banks, waysides, and hill-side pastures and downs, and cannot exist in the absence of lime. The yellow flowers are produced from July to September. There is a superficial resemblance to silverweed and cinquefoil (figured on Plate 27) but it will be noticed that the numerous stamens are bunched together round the style, instead of the filaments spreading and spacing them. The foliage consists of pairs of narrow, smooth leaves about $\frac{3}{4}$ in. long, with a well-marked midrib, dark, glossy surface, and scattered, short hairs. They are borne on slender, wiry, creeping stems. They are frequently evergreen, or nearly so. The dry fruit splits into three valves to shed its seeds.

WATER-LILY FAMILY

The Water-Lilies have their roots in mud, developing their leaves and flower buds under water. These do not unfold till the stalks have grown long enough to reach the surface. After pollination has taken place the flower closes and the stalk draws the developing fruit under the water again. The fruit is a spongy berry which softens in the water to release its seeds, which eventually drop into the mud.

All the plants have large, heart-shaped, floating leaves. They are smooth with well-marked veins, which on the underside stand out in strong ridges. Both stalks and leaves have numerous large air-spaces.

Yellow Water-Lily.—This is smaller and less attractive than the white water-lily, but is nevertheless very handsome. The cup consists

of four to six large yellow sepals enclosing many small petals which have been converted into tubular nectaries, numerous stamens, and a pistil with a prominent, flat stigma made up of many sections. The flower smells like brandy. It is found in still pools and lakes, where it is not disturbed by strong currents. The leaves and stalks feel like indiarubber.

POPPY FAMILY

Poppies are brightly-coloured flowers with their parts free from one another except in the pistil, which has several sections or carpels joined by their edges. The rest of the flower parts are attached below the pistil. There are two sepals, which fall off soon after the flower opens, four petals crumpled in the bud, and numerous stamens. All the plants have a strong-smelling latex which exudes when they are bruised or broken, and they contain opium, though this drug is commercially derived from the large opium poppy. Another member of the Family is the great celandine.

Horned Poppy.—Height, 1–2 ft. This is found on the sea coast. The flower is yellow and the foliage bluish-grey, owing to the effect of the white, waxy bloom with which both leaves and stems are frosted. The stem bears deeply indented, broad leaves, which clasp it at their base. It branches to produce a number of flowers, 2 to 3 in. across. The name is due to the extraordinary lengthening of the developing fruit which may reach to 1 ft. in length. It has two chambers producing many seeds. The flowers appear from June to September.

Red Poppy.—Height, 1–2 ft. This is a common weed of cornfields, especially on poor soil. The glowing scarlet flower needs no description. It is an annual, propagated by means of countless minute seeds which are scattered when the urn-shaped capsule opens by tiny pores round the rim. The action is like the shaking of a pepper-pot, and the opening of the pores is caused by the withdrawal of water. The flowers occur from June to August.

OXALIS or SORREL FAMILY

The Oxalis Family is closely related to the Geranium; in fact, some botanists include the two together. The parts of the flower are in fives with ten stamens in the Oxalis. The stamens are joined at the base, making the nectary more difficult to reach; insects are thus likely to press hard against the anthers and stigma and so convey pollen.

Wood Sorrel.—Height, 4–6 in. This delicate little plant, which flowers from May to August, is found in damp, shady woods and hedgerows. It has a creeping underground stem from which, at short intervals, a bud arises and produces radical leaves, a few flower-stalks, and short, fine roots. Each leaf has a long stalk and three leaflets which turn backwards slightly, closing down entirely in rainy weather. In this habit, as well as in appearance, the leaves closely resemble clover. The flower-cups, each on a long slender stalk, are white and of very fine texture, clearly veined with a purple or reddish colour.

ST. JOHN'S WORT FAMILY

There are many St. John's Worts, some of them shrubby and some herbs. Most of the wild British forms are herbs with small yellow flowers and erect, leafy stems, the leaves being simple and narrow. The flowers are star-like, having five petals and five sepals and, apparently, numerous stamens. On close examination, however, there are found to be only three or five stamens deeply divided into many branches. The garden rose of Sharon belongs to this Family.

Perforated St. John's Wort.—Height, 1–2½ ft. This wayside herb owes its name to the appearance of tiny pinpricks all over the leaves. These, however, are not holes, but transparent oil glands. Slender flowering branches grow from the erect main stem, the upper ones flowering first. The golden brown of the fruits, which are splitting capsules, mingling with the yellow flowers and orange stamens, give a rich colouring. Paired leaves grow close together along the stems. The flowers appear in late summer and autumn.

VIOLET FAMILY

The Violet Family includes pansies and violets as well as what gardeners call violas. The distinction is chiefly one of colouring, the pansies having a "face" due to the well-marked lines which serve as honey-guides to insects. Frequently, too, they have upper and lower petals of different colours. The flowers all have five free petals held together at the base by a calyx of five sepals having projections backwards beyond the stalk. The lower middle petal is drawn out into a spur which contains the nectaries. These are in the bases of two stamens which project into the spur. The flower is visited chiefly by bees, and the nectar is made as difficult as possible to obtain, by the narrow throat and by the fact that the anthers of the stamens touch each other, thus forming a tube round the

ovary and style. This narrows down possible visits to long-tongued insects which usually visit only one kind of flower on one journey, and are thus likely to carry the right kind of pollen to bring about pollination. This applies to all close-throated, long-tubed flowers with hidden nectaries, and is in contrast to the wide open, cup-shaped flowers. Note also that these features are frequently associated with an irregular shape, this applying especially to bee-pollinated flowers.

Sweet Violet.—Height, 3-5 in. This is the earliest spring violet, the dog violet following it closely. In parts of England, for example, Cornwall, sweet violets may be found even in January. The flowers are deep, purplish-blue. The sweet smell distinguishes it from the other wild violets, and the colour is deeper and has more purple in it than the blue of dog violets and wood violets. Dog violets may have a yellow spur. All the violets have a longer spur than the pansies and garden violas. The fruit is a round, three-valved capsule.

The heart-shaped leaves continue growing after the flowers have died down, both the leaf-stalk and blade elongating considerably. No doubt the leaves make stores of food for future use, for the plant is a perennial, creeping along by means of horizontal stems on the surface of the ground and establishing new plants close to the old ones. It grows by hedges and on banks. Small self-pollinating flowers, which do not open, also occur.

Wild Heartsease.—Height, 4-10 in. This tiny pansy is common in cornfields, on waste land and as a weed of gardens and allotments. It has a weak stem, often tending to be recumbent if no other plants support it. The leaves are deeply lobed and jagged. The flower has a dark purple standard and yellow lower petals marked with dark guide-lines giving it the appearance of a little piquant, surprised face. Like most violas, it produces seeds profusely in capsules which split by three *sutures*, or joinings. The splitting takes place suddenly by the drying of the wall, the edges of each valve meet and the seeds are forced out explosively to some distance.

FUMITORY FAMILY

The Fumitory Family is represented in Britain by only two types, the common weed of cultivated ground called fumitory, and the pretty yellow fumitory or corydalis found on stone walls and rocks. The garden "bleeding-heart," *dicentra* or *dialytra*, with its light green, ferny foliage, is another member.

At first sight it might be thought that these flowers were some kind of vetch, belonging to the Pea Family, but on close examination it will be

seen that, whereas members of the Pea Family can only be divided into equal halves by a vertical line passing through the middle of the upper and lower petals, in the Fumitory Family the plane of division is horizontal.

Fumitory.—This plant, which may reach a length of a foot or two, has a weak stem which seeks the support of other plants. It is chiefly a weed of waste places and cultivated ground and is local in distribution, but where it does occur, is common. It is an annual, with short, fibrous roots and light, dainty foliage, deeply divided somewhat like parsley. The inflorescences are racemes and suggest a vetch. The colour is variable, pink or purplish or brownish-crimson, with a deep red spot near the opening of the narrow flower-tube, probably a honey-guide. The parts of the flower are not joined, but pressed close together. The nectar is in a backwards-directed spur on a lateral petal. The light seeds are wind-carried.

PLATE 35. MISCELLANEOUS FAMILIES—II

FLAX FAMILY

The fragile-looking members of the Flax Family hardly suggest that the tough, resistant fibre of linen could be produced from the stems of one of them. There are several British species of flax, the best-known being the common blue flax, which is probably an escape from cultivation. Purging flax or cathartic flax is found on chalk downs and chalky pastures, and is a miniature copy of the blue flax, but with white flowers no larger than chickweed and a stem like fine wire. Its round, splitting capsules are like those of the blue flax.

Flax.—Height, in cultivation, 1–3 ft. The wiry stems are closely studded with narrow, pointed leaves, an inch or less in length. Towards the top the single stem branches to produce several flowering stems bearing one flower in the axil of each leaf. The sky-blue, censer-shaped flower has five petals and a small calyx of five sepals. The petals are delicately marked with black honey-guides. There are also five stamens. Linen fibre of one variety is the product of the stems, while the capsules of another variety give linseed, so valuable in oil-cake for cattle.

SUNDEW FAMILY

There is only one British member of the Sundew Family but three species of it occur, the commonest being the round-leaved form shown on the Plate. There is also a long-leaved form and a lesser long-leaved

form. All are bog plants, bearing a dainty raceme of a few small white flowers on a single stalk a few inches high. This stalk arises from a rosette of leaves in the late summer—July and August.

Round-leaved Sundew.—

The round-leaved form has a flat rosette of leaves, 2 or 3 in. across. The stalks broaden out into round greenish discs covered with short reddish hairs with glistening rounded tips. Round the rim is a fringe of long hairs, each ending in a shining translucent globule like a dewdrop. All these hairs

produce a sticky fluid, for they are really glands. By means of these unusual leaves the plants have an interesting method of augmenting the meagre supply of nitrogenous food they are able to obtain from the poor, watery soil. It is this characteristic that has roused the curiosity of botanists.

The glistening leaves attract flies and other small insects which come to investigate, possibly under the impression that the bright globules are drops of nectar. The whole plant draws attention by its form and colour, the leaf and flower-stalks being red. As soon as a fly alights on the surface, it finds itself sticking in the viscid fluid. As the fly struggles, the long outer hairs, which are of the nature of tentacles, are excited by the contact and bend inwards, thus making a cage round the insect. Furthermore, the leaf becomes concave in the centre, making the prisoner still more secure. Presently another fluid, much like the digestive fluid in the stomach of an animal, begins to flow. This eventually digests the body of the insect and this dissolved food, together with all the fluid, is absorbed into the leaf.

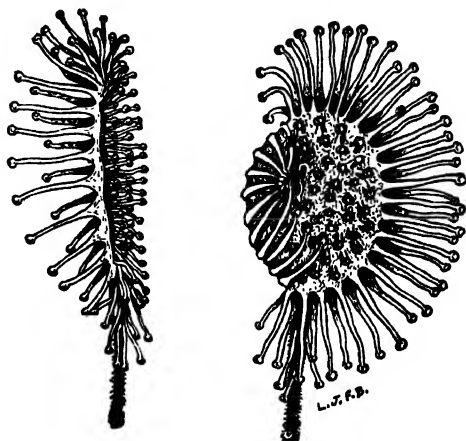


FIG. 28. Leaf of sundew.

That on the right has been touched with the point of a pencil.

SAXIFRAGE FAMILY

The Saxifrage Family consists chiefly of alpine, rock or wall plants, though the meadow saxifrage occurs in gravelly meadows, and the grass of Parnassus, illustrated on the Plate, in boggy places. The flowers are delicate starry blossoms, frequently white, and usually borne at the top of a long, unbranched stalk, either singly or in an inflorescence of a few

flowers. They differ chiefly from the stonecrops in having the carpels united, and *without* scales.

Grass of Parnassus.—Height, 7–9 in. This lovely gem amongst flowefs is found blooming in late summer in bogs and marshes. It bears one delicate shallow cup at the top of each flower-stalk, with a broad heart-shaped leaf, slightly pointed, halfway down. There are several similar radical leaves.

The chief point of interest is the plant's manner of attracting insects. The flower has its parts in fives, and alternating with the five yellow stamens are five flattened scales fringed with white threads, each ending in a shining yellow knob. These scales are really modified stamens, no longer bearing pollen, but instead, secreting nectar on their surfaces. They are called *staminodes*. Insects alighting on the flower to sip the nectar, brush against the stamens, which discharge their pollen to the outside. In visiting the next flower the insects are likely to deposit it on the branching stigma.

WILLOW-HERB FAMILY

This is a Family of herbs and shrubs, ranging from a few inches to several feet in height. It is represented in Britain by the willow-herbs, enchanter's nightshade, and by the fuchsias and evening primroses of our gardens. Most of the members have large showy flowers, especially purple and red, though the evening primroses are yellow. The leaves are long, pointed and smooth, and there are both radical leaves and stem leaves, the latter arranged alternately. The stems are often densely clothed with foliage. The parts of the flower are in fours, and the flowers are regular. There is usually a long pistil ripening into a splitting pod similar to many seen in the Wallflower Family, except that there is no dividing plate. The parts of the flower are attached *above* the ovary. All the willow-herbs have plumed seeds.

Rose-bay Willow-herb.—Height, 3–6 ft. This is one of the commonest, as well as one of the most showy, of our willow-herbs. It must be familiar to everyone, for its light seeds with their silky white circlet of hairs enable them to become established wherever a little soil is uncovered—gardens, railway cuttings, docksides, amongst demolished buildings, and on waste land. They are also common in ditches and stagnant marshy places. Once established, the plants are almost ineradicable, for they are perennials sending out radiating underground stems with attractive-looking pink buds which push up, it may be several feet away from the parent plant, to establish a new centre of activity. The young radical leaves are reddish with red veins, but they soon turn green. A tall central

flowering stem bears the handsome raceme of rose-purple flowers. The flower-stalks are orange-scarlet, and the long ovaries, which look like continuations of the stalk, are purple. The petals are rather far apart and the eight stamens hang down. The seeds are beautifully arranged in four rows with the hairs packed evenly, and as the four valves of the pod split, these are scattered on the wind.

LOOSESTRIFE FAMILY

At first sight these flowers suggest the Willow-herb Family, and indeed they are closely related, but the parts are in sixes, not in fours.

Purple Loosestrife.—Height, 2-5 ft. This plant is to be found flowering along the banks of rivers and streams, and in marshes. Its bright, rose-purple flowers are very similar in appearance to the rose-bay willow-herb, but the flowers are tightly packed against the main stem without stalks, forming a spike instead of a raceme, and the inflorescence is not so long. There are twelve points to the calyx, six petals, and twelve stamens. The leaves are opposite, not alternate, though otherwise similar to willow-herb.

This flower has an interesting method of ensuring cross-fertilisation. The pin-eyed and thrum-eyed varieties of primroses are well-known; in the purple loosestrife this principle is carried even further, there being three forms of flower, long-styled, mid-styled, and short-styled. In each flower the two sets of stamens correspond in length to the lengths of the styles in the other two forms; thus a long-styled flower has stamens which are medium-lengthed and short-lengthed. The size and colour of the pollen grains also varies in accordance with the length of the stamens. Cross-fertilisation is thus ensured, for a short style can be pollinated only by pollen from short stamens, which may come from either a long-styled flower or a mid-styled flower.

MILKWORT FAMILY

The Milkwort Family is represented in Britain only by small herbs which are found in various places amongst short, close turf, heaths, downs, and on the top of coastal cliffs. There is only one British member of the Family, though several species and varieties can be distinguished. It is very variable in colour—deep and light blue, purple, mauve and white.

Milkwort.—Height, 1-10 in. This plant flowers from June to September, while a species occurring on chalk downs flowers as early as May. It has small fibrous roots and a delicate, branching stem clothed

with narrow leaves, a little larger than thyme leaves and rather resembling them. At the top of each stem is a raceme of a few flowers—a dozen or so—on very short stalks.

The flowers resemble those of the Pea Family, and might be mistaken for vetch, but there are only three petals, and the wings are part of the calyx, though the keel is a petal. As in the vetches, the eight stamens are united. The fruit is a minute capsule.

WHITE BRYONY FAMILY

This is the Family to which cucumbers, marrows and pumpkins belong. They are quick-growing climbing plants in which many lateral branches have been modified to form tendrils. These seek support by turning about other plants. In the case of marrows the lush growth is usually allowed to trail over the ground.

White Bryony.—This is the only British representative of the Family. A glance at the picture will show its resemblance to marrows and cucumbers. The palmate leaves are broad and deeply lobed. The plant throws its long stems over hedges and twists its tendrils round twigs. The flowers are greenish-cream, due to green veins on a white ground. They have five sepals and five petals. Stamens and pistil are on different flowers and usually on different plants. There are three stamens in the one type of flower, and a rounded ovary bearing a brush-like six-pointed stigma on a short style in the other. The petals and sepals are attached *above* the ovary. The fruit is a round berry and the bright clusters, passing from green to scarlet in the autumn, form lovely garlands thrown over the hedges. By the time the berries are fully ripe the leaves and stalks have faded and shrivelled.

MALLOW FAMILY

Of the three British forms which represent this Family, the type illustrated is the most widespread and frequently seen. The Family consists of herbs with showy rose or rose-purple, regular flowers having widely spaced and spreading petals. The parts are in fives, the pistil consisting of ten segments which split away from one another without breaking open when the fruit ripens (*schizocarp*). The stigma spreads out in a brush of ten points. The large, dark leaves are rounded, or more or less deeply lobed, with a saw-like edge.

Mallow.—Height, 2–3 ft. This is a plant of waste places, corners of cultivated fields and sheltered hedge-sides. Its characteristics agree with

those just described. It bears deep rose-purple flowers, about $1\frac{1}{2}$ in. across, in the axils of the upper leaves of its erect, slightly hairy stem. It has kidney-shaped leaves with five to seven well-marked lobes. The radical leaves and stem leaves are similar. The stamens ripen and shed their pollen before the stigmas of the same flower are ready to receive it, thus self-pollination is impossible. When the stigmas ripen they are held well above the stamens, so that any remaining pollen cannot reach them.

It is interesting to notice that in the common hairy mallow or round-leaved mallow, the stigmas twist amongst the stamens and self-pollination is the rule. This is the smaller mallow often seen by roadsides, with a recumbent, downy stem and dingy flowers, $\frac{3}{4}$ in. across.

STONECROP FAMILY

This is a Family of alpine and rock plants, which may also be found on pebbly beaches. They are chiefly low-growing, creeping plants which make a mossy growth over stones. Their leaves are characterised by being swollen and succulent, for they contain mucilage cells which store water, a valuable asset in their exposed situations. It has already been noted that the flowers resemble those of the saxifrages. They are not usually borne on erect stalks, however, and they have free, or almost free, carpels with two glandular discs or scales at the base.

Biting Stonecrop.—This is one of the commonest stonecrops, and is not restricted to stony places. It is common in gardens and rockeries. Those plants which grow on wayside banks are probably escapes from gardens. It has starry, five-pointed yellow flowers growing from many short branches separately in the axils of the leaves. The ten stamens stand well away from the petals. The leaves are egg-shaped, or pointed. They are crowded and overlapping with a little spur at the base.

PLATE 36. MISCELLANEOUS FAMILIES—III

IVY FAMILY

The Family to which Ivy belongs has no other representative in Great Britain. The inflorescences are umbels, and the Family is closely related to that to which parsley, earth-nut and hemlock belong.

Ivy.—This creeping plant is characterised by having creeping stems which attach themselves to their background of banks, walls or rocks, by means of short, thick, woody roots. When the plant has become well

established it throws up a number of flowering shoots which become very bushy, often climbing and clinging to the trunks and branches of trees. The creeping shoots have five pointed, evergreen leaves which lie flat, facing the light. The flowering shoots have oval, pointed leaves, varying a good deal in shape.

The flowers bloom in October and November, providing the last feast of nectar of the year to bees and other insects. The flowers are green, with their parts in fives, attached at the top of the ovary, round a rim in which the nectaries lie. The stamens stand out boldly ; the stigma lies close against the ovary. After pollination the fruits ripen through the winter and in April they are black, *poisonous* berries. One man's poison is another man's meat, for the blackcap, returning to this country, finds in these berries a luscious feast. The inflorescences are simple umbels.

SCABIOUS FAMILY

This Family, which includes scabious and teasel, is obviously closely related to the Daisy Family. It has the same kind of composite inflorescence, or *capitulum*, which may have both tubular disc florets, and larger, lipped florets. Indeed, the points of difference between the two families can be seen only on close investigation. They are as follows :—

SCABIOUS FAMILY

Stamens 4, anthers free.

Ovary, 2-chambered.

1 Ovule, bent over.

Calyx, 5 bristles.

Leaves, opposite.

DAISY FAMILY

Stamens 5, anthers united.

Ovary, 1-chambered.

1 Ovule, upright.

Calyx, absent, or represented by pappus of many hairs.

Leaves, scattered.

Field Scabious.—Height, 1-4 ft. This handsome plant sends up a strong erect flower-stalk from between almost simple radical leaves. The stalk bears deeply divided, pinnatifid leaves. The whole plant is slightly hairy, the hairs short and stiff. The inflorescence is a flat capitulum bearing a large disc of tubular florets and having on the outside much larger florets. These are drawn out into two lips in such a way that the lower lips give the appearance of rays, not unlike the strap-shaped ray florets of a daisy. The outer florets are a clear, pale lilac colour, the inner ones a reddish-purple. The stamens are yellow. The plant flowers in meadows and by roadsides in July and August. It is also frequently found in fields and allotments as a weed of cultivation.

Teasel.—Height, 4-6 ft. This plant grows best in rather swampy ground and is often found in ditches or damp waysides amongst a tangle of tall reeds and grasses, briars and brambles. It shows the relationship with scabious in the texture of leaves and stem, by the lance-shaped radicle leaves, and by the form of its lilac-coloured inflorescence which, however, is egg-shaped instead of flat. The whole plant is covered with stiff bristles which become even more hard and woody when the fruits are ripening. The stem is strongly ridged.

The mauve florets seem veiled in green mist, due to the presence of long, pointed green bracts, later turning to woody bristles. On the outside are several very long spiky bracts guarding the capitulum like a palisade of spears.

The woody heads, after the seeds had dispersed, were for a long time used by spinners for combing the fleece in preparation for spinning it. This "teasing," or separating and straightening the threads of wool, gave the name to the plant. The bracts which clasp the stem in pairs form a cup at the base which frequently holds water. Small insects become drowned in this fluid and the teasel absorbs their dissolved bodies, thus this plant is *insectivorous*. The flowers appear in August and September.

VALERIAN FAMILY

This is another Family showing relationship to the Daisy Family by many features of its flowers, but the inflorescences are much less compact, not compressed into a head. The most marked difference is in the shape of the flower, which in this case is irregular. As in the Daisy Family, the calyx is reduced to hairs and the flower-tube is five-cleft, but there are one or three—not five—stamens. The plants have a strong odour.

Great Valerian.—Height, 2-5 ft. This plant flourishes in wet meadows, woods and swampy places such as stream-sides, and it varies in colour from pink through flesh-colour to white. Where the plant occurs, it is usually in great masses, and once planted in a garden, valerian is difficult to eradicate. It has a creeping root which sends up new buds at frequent intervals, and it will force its way under stones and obstacles to crop up elsewhere. Valerian is still used medicinally, but at one time its reputation as a popular herb was much greater. It was once known as "all-heal." Cats cannot resist the plant, and wherever it is planted in gardens they like to come to roll in it. Rats are supposed to find it equally enticing. The flowers appear from June to August. The fruits are windborne by plumes.

GOOSE-GRASS FAMILY

Three plants illustrated on the Plate belong to this Family. It is easy to pick them out by the whorled arrangement of their narrow pointed leaves, as well as by their inflorescences of minute flowers branching from the axils of these leaves. On close examination it is found that what is apparently a cyclic arrangement of the leaves is due to there being two opposite leaves, each having from its base a number of outgrowths called stipules. These have the same character as the leaves and, therefore, give the impression of a large number of leaves. The flowers are small and regular; the calyx is minute; the corolla is a united tube; the ovary is in two parts.

Goose-grass.—This climbing-plant is the commonest British member of the Family, being found in hedges everywhere. The whole plant is covered by short bristles or rough, hooked hairs, which make it feel quite sticky to touch. These roughnesses are most useful in helping it to cling to other plants and so support its weak stems. There is a circle of apparently eight leaves at each node, rounded at their tips. The flowers are minute, with four white petals and four stamens. The two carpels are covered with small hooked tubercles or hair-like swellings, which grow more effective as the fruit increases in size. Finally, the carpels separate and the rounded halves catch on to wool and fur and so are scattered. The common name "cleavers" indicates the impression of its character this plant has made upon popular opinion.

Lady's Bedstraw.—This has very thin stems, eight fine, thread-like leaves at each node, and near the top, masses of minute yellow flowers. It is dainty and delicate-looking, with a sickly-sweet smell. In the days when rushes, bracken or heather were strewn for beds, it may be that lady's bedstraw gained its name from a similar use. Another suggestion is that it was the bedstraw of Our Lady, the Mother of Jesus.

Hedge Bedstraw.—This plant, like goose-grass, has white flowers, but in long terminal sprays, not small axillary clusters. It is coarser-looking than lady's bedstraw, but finer than goose-grass, from which it can easily be distinguished by the absence of rough hairs. The leaves are smaller and pointed.

HONEYSUCKLE FAMILY

The majority of members of this Family in Britain are shrubs, though honeysuckle itself is a woody climber. The smallest member is a tiny herb, moschatel, whose quaint little green inflorescences of fine flowers

must be sought out in shady banks and woods during April and May. Elder, guelder rose and wayfaring tree are other members of this Family. The leaves are in opposite pairs.

Honeysuckle.—This sweet-smelling flower with the scent of honey is visited in the dusk by long-tongued moths and its whole structure is directed to encouraging these visits. The nectar is at the base of a long corolla-tube, of which the rim is divided into two lips, the lower curving backwards. Five stamens are borne on very long filaments, and the style is also long. Movements of the filaments bring the anthers into such a position that they will be brushed against by visiting insects, and afterwards they bend down out of the way so that the stigma is prominently exposed. The inflorescence is a simple umbel, and the fruits a cluster of *poisonous* scarlet berries. Honeysuckle flowers from June onwards.

The woody stems twine round one another and throw their "bines" over bushes and small trees. Woodbine and eglantine are other names for the plant.

PERIWINKLE FAMILY

There are only two British members of this Family, the greater and lesser periwinkles, both having regular purplish-blue flowers with a salver-shaped corolla, that is, like a dish with a flat rim and sunken centre. The dark, glossy foliage is evergreen; the leaves in opposite pairs. The chief difference is in the size of flower and length of stem. Both are recumbent, but in the greater periwinkle the stems do not root. The flowers are occasionally white.

Lesser Periwinkle.—This plant is found on banks amongst grass and other plants where the water supply is good. The stems root at intervals where they touch the ground. The flowers are $\frac{3}{4}$ –1 in. across, and appear in April and May. The glossy leaves are narrow, oval in shape, and pointed, with entire edges. They grow in pairs at short intervals apart. The flower has a curiously elaborate stigma which blocks the centre; it has a spreading brush-like end, and beneath this a disc bearing the nectaries. The parts are in fives with two carpels united only by their styles; the fruit consists of two follicles.

PLATE 37. MISCELLANEOUS FAMILIES—IV

BELLFLOWER FAMILY

The Bellflowers or Campanulas all have in common the five-pointed, bell-shaped flower formed by the union of the petals. They have five

sepals and five stamens all attached above the ovary^f which is small, and, if cut across, will be seen to have its ovules attached to a central rod. The flowers are showy and variously arranged. The leaves are alternate. Most of the plants are herbs which may be annual, biennial, or perennial. Their situations are very varied, for they are found in woods, fields, dry pastures, banks and hedge-rows.

Nettle-leaved Bellflower.—Height, 1-3 ft. This sturdy plant is found in shady woodlands. It has a rough stem and rough, dark green leaves which are ovate with a long point and toothed edge. The flowers are rich purplish-blue, growing in twos or threes in the axils of the upper leaves, forming a spray at the top of the erect, unbranched stem. The plant flowers from July to September.

Harebell.—Height, 6-24 in. This, the bluebell of Scotland, is an airy, dainty plant with fine, wiry stems producing a number of single flowers each on a long, almost thread-like stalk. The calyx is drawn out into five long, narrow, pointed sepals; the leaves near the base of the stem are long and narrow, while short, narrow bracts mark the base of each flower-stalk where it joins the main stem. The flowers resemble those of the bellflower just described, but are much more delicate. Occasionally white ones occur. The harebell is found on heaths and dry, sandy wayside banks. It flowers from July to September.

Sheep's Bit Scabious.—Height, 6-10 in. This differs from nearly all other bellflowers in having the flowers, or in this case florets, concentrated into a compact, flat head or capitulum, as in the Daisy Family. The heads are small, $\frac{1}{2}$ - $\frac{3}{4}$ in. across, the florets bright blue and deeply cut into five points, so that they have not the typical bell shape. The clusters of stamens stand up stiffly above the corollas.

The leaves which clothe the lower part of the stem are narrow, wavy and blunt, while small, narrow bracts are found near the base of the long, erect and rigid flower-stalks.

The situation is the same as for harebells—in fact, they are frequently found together, and the time of flowering is the same. The colour is a clear, bright blue. Incidentally, the flowers should be distinguished from the devil's bit scabious, which belongs to the Teasel Family. It has a larger, flatter head, mauve in colour, and with distinct ray florets. It has also deeply indented, pinnatifid radical leaves.

PLANTAIN FAMILY

This is a Family with wind-pollinated flowers for which bright colours are not necessary. We find, therefore, inconspicuous green florets with

two rings of minute floral leaves, indistinguishable from one another as five petals and five sepals. The four anthers are large and borne well away from the flowers by long, delicate filaments easily swayed by the wind. The pollen is dry and copious. The flowers are crowded together into spikes or heads, which are borne high above the foliage on a long, stiff stalk, and are thus exposed to the wind. All the features of the flowers serve this one end of wind pollination. The tiny, dry fruits open by a lid to let out the minute, light seeds, also wind-borne. They resemble miniature acorns in appearance.

Lamb's-tongue Plantain.—Height, 6–12 in. This is an attractive-looking plant with broad downy leaves and a long spike of flowers which, as they mature, hang out large mauve or pinkish-purple anthers, beginning at the base and proceeding upwards. The leaves are broad oval, narrowing at the base, with strongly-marked parallel veins. Lamb's-tongue plantain is also known as hoary plantain from the frosted appearance given by the short silky hairs which cover it. It is found in chalky or limestone pastures, and flowers from June to October.

THRIFT FAMILY

This Family contains only two British types, both maritime, thrift or sea pink, and sea lavender. They are stiffly-growing herbs with the frosted stems and foliage so characteristic of seaside plants, due to a film which helps to prevent too great a loss of water. There are five sepals, five petals, five stamens, and one ovule. The calyx is scaly and brightly-coloured.

Sea Lavender.—Height, 4–12 in. This plant is characteristic of mud flats and salt-marshes, flowering in July and August. It has elongated radical leaves not unlike those of the Michaelmas daisy, and wiry flowering-stalks. At about half their height, these branch at wide angles several times, the smallest branches bearing minute florets all on one side in short, dense spikes. The lavender colour of the florets gives the plant its name.

Thrift.—Height, 2–12 in. At first sight this plant resembles the scabious, except that the flowers are pink. The chief difference in botanical detail is that there is only one seed instead of many. There are also a scaly calyx and several brownish, scaly bracts below the head of florets. The foliage resembles a wiry heath grass from amongst which the long, erect flower-stalks shoot up. It is perhaps the commonest of our seashore plants; it is also found on mountains. It flowers from April throughout the summer and varies enormously in height according to its situation;

where the soil is scanty or the flower is exposed to strong winds, it blooms at a height of an inch or two from the ground.

GENTIAN FAMILY

Most people would think of gentians as the beautiful, heavenly-blue, bell-like flowers of the Swiss mountains and other alpine positions, and few perhaps realise that the Family is represented in Great Britain. Though the true gentians are not at all common, being confined to certain high grassy places, calcareous pastures and peat-bogs, we have other members of the Family more commonly and widely distributed. These are the pretty rose-coloured bog bean, yellow wort, with its grey foliage clasping the stem so that it appears to pierce the round leaves, and the lovely pink centaury found on many chalky or limestone pastures and downs.

Centaur.—Height, 6–18 in. This pretty annual herb is found in dry pastures, especially on chalk or limestone and on slopes. The flowers are bright pink, rather china-like in texture, and they rise stiffly from a slender, branching stem in an inflorescence which is more or less level, though the flowers actually spring from branches at different heights. The five sharp points of the corolla spread out from the top of a long, narrow corolla-tube which is enclosed by a slim green calyx, also tubular. The pistil is enclosed by the floral tube and the five anthers project from it. The square stalk is punctuated by pairs of narrow, smooth leaves, with entire edges.

HEATH FAMILY

These are all shrubs and under-shrubs, that is, miniature but woody. They have more or less evergreen leaves; slender, wiry, woody stems; and usually pale pink, deep rose or purplish-red flowers which are minute and clustered in long or short racemes. They are, as the name suggests, all found on heaths, usually in large quantities where they occur, and are, therefore, lovers of sandy soil which is often poor in nitrogen. The flowers in all the heaths are small bells with united petals enclosing the pistil.

Heather.—Height, 1–4 ft. The plant, also known as common ling, flowers from July to October and the masses of purplish-rose flowers stain the mountain-sides so that they can be seen from miles away. Each flower is minute, but the spike-like racemes are so crowded that they are conspicuous and attract multitudes of insects, especially bees, for the nectar which makes delicious honey. Perhaps the famous "heather ale"

of the Picts may have been made from heather honey. On close examination each flower is seen to have a coloured calyx of free sepals which are longer than the corolla-tube. The dark green leaves are minute and arranged in closely over-lapping pairs, so that the stem appears to be scaly. Where the growth is luxuriant, there may be a tough, woody main stem of a foot or more, branching out widely at the top into a bushy mass of subsidiary stems.

Cross-leaved Heath.—Height, 1–2 ft. This belongs to the true Heaths, a different genus from that of the ling. It is found on wet heaths, and is a smaller plant than heather, but its flowers, of a lovely soft rose pink, are larger than those of heather and of a globular or bell shape, with five tiny projecting points. There is a very small, green calyx, in contrast with the coloured one of heather. The whole plant, including even the ovary, is slightly downy, and the bells might be modelled in wax or china, their texture is so fine. The narrow, pointed leaves grow in whorls of four at short intervals up the slender, wiry stems, thus giving the plant its distinctive feature. The upper leaves are shorter than the lower, which may be about $\frac{1}{3}$ in. long.

PLATE 38. MISCELLANEOUS FAMILIES—V

CONVOLVULUS FAMILY

The plants of this Family are herbs which generally climb by means of twining stems. The Family includes the Bindweeds or Convolvuluses—the field bindweed or the corn bindweed, the great bindweed and the sea convolvulus. It also includes the curious little parasitic dodder which, lacking green colouring matter and, therefore, the ability to make carbohydrate food, penetrates by means of fine branches, heather, furze and clover plants, obtaining food from them.

The Bindweeds have the flower parts in fives, with an ovary of two compartments, each with two ovules. The flowers are like miniature lamp shades, the corolla being narrow at its point of attachment and wide at the rim. They have underground, creeping stems.

Field Bindweed.—This weed of waysides, cultivated fields and gardens, creeps along by means of its twining stems, which cling to any other plants they touch. The white, very brittle, underground stems spread deeply in all directions, sending up buds which give rise to new plants. They are very difficult to eradicate, as even small broken portions produce buds. The leaves are shaped like arrow heads and are alternate; the flowers arise singly from the leaf-axils by long thin stalks with a pair

of minute, narrow bracteoles. The wide open, pale pink or white chalice attract long-tongued insects, which must press against the anthers to reach the nectar at the base of the cup.

BUTTERWORT FAMILY

There are only two British members of this Family, both insectivorous, in which respect they resemble the sundew. They are the bladderwort, a submerged aquatic plant having leaves forming tiny bladders or flasks, and the butterwort, found in bogs and wet places in similar situations to the sundew, in fact frequently with it.

Butterwort.—Height, 2–6 in. There are several species of these plants, all small herbs with rosettes of pointed, hollow, radical leaves, the flowers arising from the centre singly on long, straight stalks. The flowers are irregular and look much like violets, as they have a long spur and are of a bright violet colour. The leaves exude a sticky substance which makes them shine, and they attract insects which are caught in the copious fluid. A digestive juice is then poured out which dissolves and digests the insect's body, and the liquid food is then absorbed. The process is similar to that which takes place in the sundew, and ekes out the scarce supply of nitrates in the watery soil. The flowers are found from May to July.

WILLOW-HERB FAMILY

This Family has already been described in Plate 35, page 144.

Enchanter's Nightshade.—Height, 1–2 ft. This slender herb is found under shady trees in woods and copses. It has a single graceful stem with dark green, paired leaves, oval, toothed and with a pointed apex. The flowering sprays are racemes, which are both terminal and in the axils of leaves. The flowers are delicate pink and white, borne on short slender stalks. They are much less showy than the willow-herbs, owing to the smallness and wide-spacing of the flowers.

NIGHTSHADE FAMILY

This Family of herbs and woody shrubs is remarkable for the fact that *all* its members are more or less poisonous, some of them deadly poisonous in all their parts, others only at certain stages or under certain conditions. Thus, potatoes which have turned green or begun to sprout may develop a narcotic poison ; green tomatoes may affect some people. Thorn apple,

with its prickly fruits, henbane, and the tobacco plant, all contain narcotic alkaloids which are highly dangerous. The flowers are tubular, with a five-lobed corolla representing five petals, and the fruits are berries, borne inside the calyx.

Bittersweet.—This common climbing plant with its woody, twining stems, is often called woody nightshade. Its drooping racemes have spiky purple flowers with startling yellow centres formed by a pyramid of stamens surrounding the style and stigma. The leaves have three or more lobes, the terminal one being the largest. The whole plant has a strong, sickly smell, especially when plucked or bruised. The glistening, ruby-like berries are very pretty and harmless but the rest of the plant is poisonous.

Deadly Nightshade.—Height, 2-4 ft. This is the *bella donna* (beautiful lady) which produces the drug atropine, used by "beautiful ladies" in ancient times to make the pupils of their eyes large and bright—hence the plant's name. All parts of this plant produce this dangerous narcotic alkaloid. It is a bushy, but not woody, plant, with broad, oval, dark green leaves, and bell-shaped flowers growing singly or in small clusters in the axils of leaves, one only being open at a time in each axil. The flowers are dusky-reddish or brownish-purple, and the large berries are black. They are surrounded by the five points of the calyx and are attractive-looking but very dangerous.

BLACK BRYONY FAMILY

It is a pity that the black bryony and white bryony should be known by these confusing names. While white bryony shows by its leaves and flowers its relationship to cucumbers and marrows, black bryony is not even distantly related to this Family, but belongs to one of which it is the only British representative. To describe this plant is, therefore, to describe its Family.

Black Bryony.—This is a woody climbing-plant common in hedges. It resembles honeysuckle, great bindweed and hop in climbing by means of twining stems. Its leaves resemble those of great bindweed, being heart-shaped, with a long point, but they are much more glossy and the veins are conspicuously marked. The flowers bearing stamens are on different plants from those bearing the ovary. They are yellowish-green, and the parts are in sixes, with an ovary of three chambers. This characteristic links black bryony with the daffodil, snowdrop and iris figured on this Plate which are *monocotyledons*, and distinguishes them from all the plants hitherto described, which are *dicotyledons*.

DAFFODIL FAMILY

It is necessary before describing this Family to explain the chief differences between monocotyledonous plants and dicotyledonous plants.

Monocotyledon means one seed-leaf, while dicotyledon means two seed-leaves. Flowering plants with enclosed ovules—this excludes the cone-bearing plants such as pines—are divided into two classes in accordance with this characteristic. It is found that several other characters are linked with this main one.

1. Generally, monocotyledons have the parts of the flower—sepals, petals, stamens and pistil—in threes or multiples.

Dicotyledons usually have the parts in twos or fives or multiples.

The ovary, however, may be reduced to only one chamber, while in both classes some parts may be missing.

2. Monocotyledons usually have radical leaves with *parallel* veins. They may have stem-leaves ; e.g., black bryony has stem-leaves with *net* veins.

Dicotyledons generally have *net* veins, though there are exceptions.

These features help to establish a broad basic classification of flowering plants.

To return to the daffodil, we notice at once from the picture that it agrees with the monocotyledons in the points mentioned above. The parts of the flower are two rows of three floral leaves called *perianth* (round the anther) leaves, since they are all alike and cannot be distinguished as calyx and corolla. They are free, but produce on their inner surface a tubular growth, the *corona*, which protects the stamens. The stamens are in two rows of three, and the ovary, if cut across, will be seen to have three united chambers. The parts of the flower are attached *above* the ovary. There is one stigma.

Plants of the Daffodil Family are chiefly grown from bulbs. The leaves are all radical, and have parallel veins. The Family contains all the narcissi.

• **Daffodil.**—Height, 6–12 in. The wild daffodil is found in fields in secluded places but is becoming rare owing to careless gatherers who pull up the bulbs. It is the Lent lily of the poets, flowering in March and April. It has a straight, slightly crinkled trumpet or corona, as long as the perianth leaves (about 2 in.) and is of a deep yellow colour. The drooping head as well as the corona protect the stamens from rain. The flower bud is protected by a sheathing bract, which afterwards becomes dry and papery. The leaves are long and narrow.

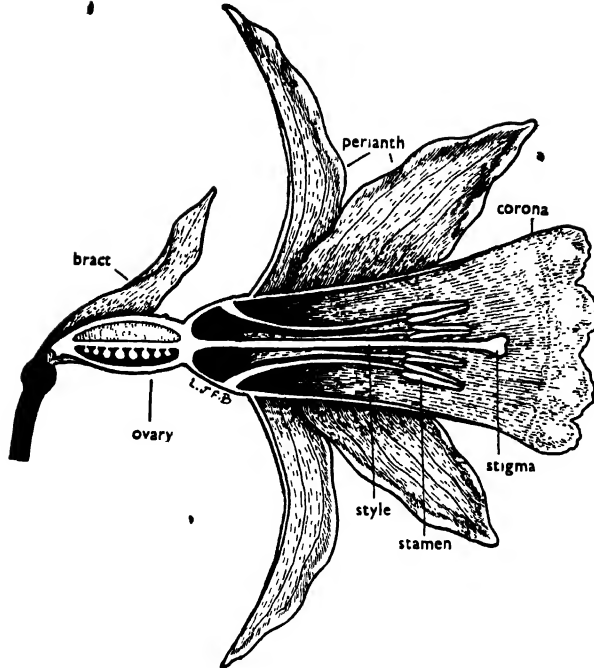


FIG. 29. Daffodil flower in section.

Snowdrop.—Height, 6–10 in. The flowers, which appear in woods in February and March, are solitary, borne on a flower-stalk springing up between two radical leaves which are keeled. Like the daffodil, it springs from a bulb. Both can, of course, grow from seeds, but these take several years to produce flowering bulbs. The parts of the flower agree with the daffodil, and the pollen is protected in the same way, but there is no corona. The flower is white with a green spot on the outside of the outer perianth leaves. A long narrow bract springs from the flower-stalk and ensheathes the bud.

IRIS FAMILY

This Family closely resembles that of the daffodil and snowdrop. The chief differences are that in this Family there are only three stamens, instead of two rings of three, and whereas in the Daffodil Family there is only one stigma, in the Iris Family there are three. These curve outwards and are flattened and brightly coloured like perianth leaves, adding greatly to the attractiveness of the flower. In some of the cultivated irises these are

very ornate. The foetid iris, or gladdon, has a capsule with bright orange-scarlet seeds. Crocuses and gladioli belong to this Family.

Yellow Flag.—Height, 1-4 ft. This is common in June on the borders of streams and pools. The outer perianth leaves are broad and drooping, the inner ones much smaller, and the stigmas long and narrow. Several flowers grow at the head of a thick, erect stalk, opening one or two at a time and emerging from a complicated sheathing of overlapping bracts. They become furled again after flowering while the fruit develops. The fruit is a three-valved capsule.

The plant has a creeping rootstock, thick and fleshy, and as new leaves are produced at very short intervals, this stem is closely notched with the leaf scars. The leaves are tall, broad and sword-shaped.

PLATE 39. MISCELLANEOUS FAMILIES—VI

All the plants on this Plate belong to the class of monocotyledons, that is, the seed has only one seed-leaf, and associated with this character, the parts of the flower are typically in threes. (Some parts may, however, be absent.) The leaves are usually parallel-veined. In many cases they are radical, that is, they grow from the level where root and stem join. Nearly all true bulbs are found amongst monocotyledons, and they include the Grasses, Rushes and Sedges, the Grasses especially being a highly successful Family of great economic value, since both their foliage and seeds are an extremely important source of food.

LILY FAMILY

The flowers of this Family have a perianth of six floral leaves, an outer row of three and an inner row of three. These cannot be distinguished as petals and sepals since they are all alike. There are two rows of three stamens. The ovary has three valves or carpels joined to form a central rod which bears the ovules. This rod continues upwards as the style, with a single, knob-shaped stigma. The Lily Family differs from the Daffodil Family only in having the flower parts attached below, not above, the ovary.

Butcher's Broom.—Height, 1-2 ft. This small shrub is peculiar in having no leaves, their place being taken by leaf-like outgrowths of the stem, known as *cladodes*. These are oval and end in a sharp point. They are evergreen. The only external sign that they are not leaves is the presence, in the centre of each one, of a minute, scaly flower. The

flowers are of two kinds, some bearing stamens only, and the other, pistils. The pistillate flowers give rise to large, globular, scarlet berries.

Bluebell.—This is perhaps our most familiar and most loved spring flower of the woodlands, growing as it does near large industrial towns just as successfully as in the depths of the country. The racemes of blue flowers appear in May and the beginning of June, to be followed by the "little candles," the pale rounded ovaries drawn out into a long style bearing a knob-shaped stigma—the "light." The shrivelled perianth leaves still partly enclose the ovary but soon fall away as the fruit ripens. This is a papery capsule containing fairly large, round black seeds. These are self-setting, yet, though they must germinate in great number, it is extraordinarily difficult to find the tiny green, spear-like leaves of the seedlings. The seed-leaf is tubular and is pierced by the first foliage leaf which emerges at the side. (Onion seedlings, which are similar, are most interesting to watch unfolding.) It takes two to three years for the plant to produce a full-sized bulb. After that, new bulbs are produced inside the old one each year. The spear-like, green radical leaves enclose the flower bud; the flowers have six free perianth leaves, six stamens and a three-chambered ovary enclosed by the perianth. A narrow, bluish bract grows below each flower. The hanging position of the bells protects the pollen from rain.

WATER PLANTAIN FAMILY

The commonest members of this Family are the water plantain, arrow-head and flowering rush, all vigorous, strong-growing plants which bear their flowers above water, while the leaves are partially submerged or floating.

Arrow-head.—Height, 6–18 in. This is a fairly common, shallow water plant. It roots in the mud of stagnant ponds and ditches by means of a creeping rootstock which soon increases the area occupied. The leaves and flowers are borne on long stalks above the level of the water. Leaves, flowers and fruits all have a striking form. The large leaf-blades are shaped like an arrow-head and have boldly marked veins. The flowers form a compound raceme consisting of three whorls of three flowers separated by an elongated stalk. The fruits are green and burr-like, consisting of many crowded achenes. The bases of the three flower-stalks of each whorl join round the stem. Each flower has three green sepals holding a shallow cup of three large white petals, with a purple blotch on the claw by which it is attached. Pistillate and staminate flowers occur on the same plants. The flowers are in bloom from July to September.

Flowering Rush.—Height, 2–4 ft. This relation of the arrow-head is found beside streams. Its purplish-pink flowers are obviously similar,

but the outer perianth leaves are of the same colour^l as the inner. The flowers all spring from one point in an umbel at the head of the flower-stalk, which is three-sided. The radical leaves are long and spear-like. The flowers appear in June and July.

ARUM FAMILY

This Family has only two British members, the wild arum and the sweet flag. The chief characteristic is the curious inflorescence which consists of a spike of flowers thickly crowded together and reduced to the barest essentials, that is, pistillate flowers comprising only a pistil, and staminate flowers consisting entirely of stamens. The flowers have no attractive perianth leaves. To make up for this lack, there is a large bract attached below the inflorescence and extending far beyond it. This serves the purpose of bright-coloured petals, for it is a strikingly conspicuous structure. In exotic forms it may be dazzling white, as in the common arum, which is a South African weed; or it may be brightly coloured. The bract is called a *spathe* and the spiked inflorescence a *spadix*. Spathe and spadix together make a striking combination. Nearly all arums are poisonous.

Cuckoo-pint or Wild Arum.—This plant has greatly struck the popular imagination and it has several folk-names—lords-and-ladies, Jack in-the-pulpit. It is indeed an extraordinary-looking and handsome plant. It is one of our spring flowers, occurring amongst lush grass on the sides of ditches or under hedges. The glossy, dark green, radical leaves are like arrows or spear-heads, and have strongly marked net veins. From the centre of the group rises a pale green spathe closed protectively round the lower part of the spadix, but flaunting

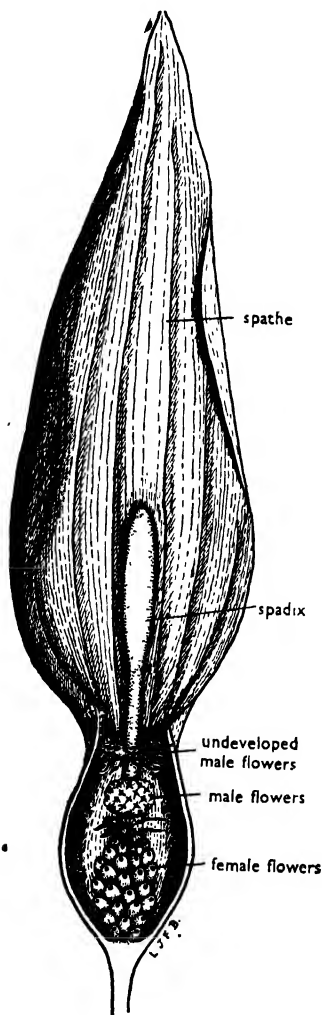


FIG. 30. Inflorescence of wild arum in section.

and wide-spread like a banner above. Small flies of the midge type are chiefly attracted to the flower which has a disagreeable foetid smell. They crawl down the spathe touching all parts in turn. The smooth chocolate-coloured top of the spadix is club-shaped, then come a few sterile flowers forming a spiky barrier pointing downwards which the flies can easily pass as they descend, but find difficult on the return journey. Next, there is a cluster of staminate flowers, a few more spiky hairs, and immediately below this a clump of pistillate flowers which ripen before the stamens. The pistillate flowers provide nectar on which the midges feed. If they have already visited other flowers, they are covered with pollen, which they deposit on the ripe stigmas. The lower, sterile hairs then wither and permit the midges to ascend as far as the staminate flowers. As these are now ripe, the midges are thoroughly dusted with pollen, and the upper rows of spikes now wither and allow the insects to escape. Flies are much attracted by carrion smells and most arums have at least a slightly unpleasant odour.

In the early autumn the clusters of scarlet berries gleam under the hedges. These are the fruits of the cuckoo-pint, but as all traces of the spathe have vanished and the leaves have decayed, the connection is not obvious. There are no other berries, however, in similar situations. The seeds of the gladden or foetid iris, which are nearly the same colour and grow close to the ground, are revealed by the splitting of a three-valved capsule, so there should be no confusion.

ORCHID FAMILY

This Family, which includes many bizarre tropical forest forms, is represented in Britain by a number of dainty, delicate herbs, some of them now very rare. The six perianth leaves combine to form many fantastic shapes, and they are frequently provided with a spur containing nectar. The long ovary, which looks like a flower-stalk, is twisted. There is an elaborate means of securing cross-pollination by insects. The two pollen masses in the single fertile anther are drawn out into a short stalk, easily detached by the pressure of an insect's head. These masses, called *pollinia*, are then carried away looking like an extra pair of short feelers, and deposited on the sticky stigma of another flower.

Purple Orchis.—Height, 1–2 ft. This lovely, reddish-purple flower is found in woods and damp meadows in May and June. It is the commonest of our orchids. The flower-stalk rises from a cluster of radical leaves which are broad and rounded at the apex, and may be spotted with chocolate-purple. Note the twisted ovary which looks like a flower-stalk,

and the irregular shape of the flower with its well-marked lip on which insects can alight. The smell is unpleasant, especially after the flowers have been brought indoors.

GRASS FAMILY

The three families of the Grasses, Rushes and Sedges show an interesting evolution of the flower in connection with wind pollination. Rushes, which are closely related to the Lily Family, have flowers on the same plan, but the attractive perianth of floral leaves, which draws the attention of insects to such flowers as the bluebell, has become reduced to six very small, scaly perianth leaves. In the sedges the reduction has been carried further, while in the Grasses no perianth at all remains, the essential parts of the flower—stamens and pistil—being protected by a number of overlapping scaly bracts, called *glumes*. The flowers are crowded together in small clusters called *spikelets*.

The three anthers are large and suspended midway by long, delicate filaments, so that they swing in the wind enabling the pollen, which is very light and dry, to be readily scattered. The two stigmas are feathery, so that their roughened surface can easily catch and hold the pollen. The flowers are stalkless, or *sessile*. The inflorescences are complicated; the spikelets may be in many-branched *panicles* as in the grasses illustrated on the Plate.

The leaves are narrow and parallel-veined. Those growing from the stem are sheath-like at the base, while the upper part projects at an angle. Where a leaf branches off from the stem it is strengthened by a short, collar-like outgrowth called a *ligule*. This, and the swollen nodes, are typical features of the Grasses. Many have creeping, persistent underground stems.

The grasses have high economic importance both for the value of their vegetative parts as fodder, and for their albuminous seeds as staple cereals.

Vernal Grass.—Height, 6–18 in. This is common in pastures, and is sown in mixtures for fodder. It has a pleasant, sweet smell and is often called sweet vernal. The spikelets are clustered in a close panicle interrupted near the base. The inflorescence is about $2\frac{1}{2}$ in. long, and the foliage-leaves are narrow. There are short bristles or awns below the florets. The stamens are yellow and hang well away from the florets when the grass blooms in June and July. It is a perennial.

Quake Grass.—Height, 6–12 in. This grass is also found flowering in pastures in June and July. Its florets are clustered in flat, ovate or rounded spikelets about $\frac{1}{4}$ – $\frac{1}{3}$ in. across, pale brown or slightly iridescent

purplish-brown in colour. The loose panicles have very fine stalks which cause the grass to shiver or tremble in the wind. The leaves are rather broad at the base and pointed. This is a very dainty, attractive grass.

Great Reed.—Height, 3-6 ft. This is the largest of our Grasses, strong and coarse growing. It has dark green, spear-like leaves $\frac{1}{2}$ in. broad and 1-2 ft. long, harsh to touch and strongly veined. The flowers are purplish-brown in great loose panicles 6-12 in. long. The glumes are long and pointed. This grass is common in sluggish streams and marshes and it is a perennial.

PLATE 40. MISCELLANEOUS FAMILIES—VII

RUSH, REED AND SEDGE FAMILIES

The names Rushes, Reeds and Sedges are popularly used to denote various waterside and marsh plants of a grass-like nature, but botanically three distinct Families are recognised. Without going into the minute details by which botanists distinguish them, we may note here that the Rushes have perfect flowers like the Lilies, but the perianth leaves are minute and scaly; the Sedges either have the perianth represented by six bristles, or it is completely absent. The reed mace and bur reed type have a spadix or spike, as in the Arums, with staminate and pistillate flowers in different parts of the inflorescence. There is, however, no bract or spathe. Many of the Sedges can also be readily distinguished by the three-sided stem, its ridges often as hard and sharp as a knife.

Great Reed Mace.—Height, 3-7 ft. This tall, striking plant has long, spear-like leaves, from the midst of which, in June and July, arise the great cylindrical spikes or spathes of flowers. The lower part of the spathe is about 1 in. thick and consists of tightly-packed, pistillate flowers each with a hair-like perianth. From these, after pollination, the seeds are formed. The cylinder persists. The dried heads were a favourite decoration in Victorian drawing-rooms—generally, but incorrectly, being known as bulrushes. The cylinder narrows near the top, where the staminate flowers are found. Each of these consists of three stamens surrounded, like the pistillate flowers, by bristles. The plants are found in streams and pools and have a perennial rootstock.

Bulrush.—Height, 1-8 ft. The bulrush is one of the Sedges and has a typical triangular stem. The tall, erect stem gives rise to a loosely-branching panicle of spikelets, closely resembling one of the Grasses, of a deep, rich brown colour. On examining a single flower, it will be found to have the perianth represented by three rough bristles, thus being

distinguished from the Grasses. There are three⁴ stamens and three stigmas. Grasses have only two.

Common Rush.—Height, 1-3 'ft. This rush is known to everyone, as it is found wherever water-logged ground gives it a footing—in wet pastures and bits of boggy woodland as well as in moorland marshes. Like all the Rushes, its hollow stem is stuffed with pith. In some Rushes this stem is jointed but in the common rush it is continuous. The stem is rather soft and faintly striated. The flowers, of a warm brown colour, are borne in a dense, compact panicle on the side of the stem about half-way up. There are a few solid leaves, looking like stems, and others are reduced to scale-like sheaths. Individual flowers have a perfect, though minute, scaly perianth of six segments.

MISTLETOE FAMILY

These are leafy shrubs which are parasitic on trees, and are mostly tropical. They belong to the class of dicotyledons, which have two seed-leaves, but the mistletoe is placed on this Plate, at the end of the flowering plants, because it stands alone in its habit. Though there are many parasitic or semi-parasitic flowering plants, mistletoe has certain definite characteristics of its own. It is the only British parasitic *shrub*, and though traditionally associated with oak and, indeed, found on oak trees in Eastern Europe, it rarely grows on this tree in Britain. It is perhaps most common on apple and poplar trees.

Mistletoe.—This plant has sticky white berries which are much appreciated by certain birds, and especially by the mistle-thrush. Birds deposit the seeds on the trunks of trees, where the sticky substance still adhering to them enables them to become fixed. On germination, the seed sends out a short root-like sucker which penetrates between the bark and wood of the tree and, branching, absorbs nourishment from its host. Stems bearing paired green leaves develop very slowly, eventually forming a dense, bushy evergreen shrub. The green leaves are able to make some food for the plant, but the supply is greatly augmented from the stores of the tree. Minute green pistillate and staminate flowers, with four-lobed perianths, form in the spring, and from the pistillate flowers the berries are eventually produced.

SEEDLESS OR SPORE-BEARING PLANTS

There is a large group of plants that is more primitive than the flowering plants. Its members are extremely varied in their vegetative features.

Though the higher types have well-developed leaves, stems and roots, the lower kinds may consist merely of fine, thread-like strands or filaments, indistinguishable into different parts performing different functions. They may have a broad, plate-like form, with, perhaps, thick cylindrical holdfasts but no true roots, as the Seaweeds. They may consist of minute spherical bodies each comprising only a single cell, as in those plants which form a green, powdery scum on the bark of trees, or wooden railings.

Many of the seedless plants are green, that is, they contain leaf-green or chlorophyll, and are therefore capable of manufacturing their own carbohydrate food in the presence of sunlight. Others have no chlorophyll, but live parasitically on other plants or animals. All, however, have one point in common; they produce young by means of small unit masses of protoplasm, called *spores*. These are generally, but not invariably, surrounded by a hardened, protective outer wall. They are usually resistant to the drying effect of air (dessication), and to other adverse conditions such as extremes of heat and cold. Most of them are air-borne and thus capable of wide dispersal.

Spores are borne by specialised bodies or organs, variously named according to their structure. These protect the spores until they are ripe for dispersal.

The spore-bearing plants, although less generally familiar than the flowering plants, present many features of economic importance. Their light spores settle in all kinds of situations, germinate and carry out their life cycle; then the plants, dying down, leave behind a little mould which decays and helps to form soil. They may be regarded as pioneers of vegetation. This applies particularly to the Lichens, which help to disintegrate the surface of rock on which their spores settle, and to many small Mosses and Ferns which are not exacting in their requirements. Many kinds of Bacteria and Fungi help to decompose the dead bodies of plants and animals upon which they feed, thus starting the formation of humus. A certain lichen—the so-called reindeer moss—forms the staple diet of reindeer, and thus makes life possible for many dwellers in the Arctic Circle.

Spore-bearing plants must have lived for thousands of years before flowering plants appeared. Those which exist to-day are but a remnant of the far greater number of forms, often of great size, which populated the swamps and formed the forests of an earlier epoch. Gigantic Ferns, Horsetails and Stagshorn Mosses were particularly characteristic of the forests of the Coal Measures, formed in what is known as the Carboniferous Age.

FUNGI

Fungi are plants which have no green colouring matter, so that they have been forced to find some alternative means of obtaining food to that of green plants. The latter make their own carbohydrates and then build up from these, and from food obtained from the soil, the more complex substances needed for body-building. The solution achieved by the Fungi is to penetrate the tissues of other plants or animals from which they extract all the food they need, carrying out a sort of digestive process. The supporting plant or animal is called the *host*. The Fungi are termed *parasites* if they feed upon living hosts, and *saprophytes* if they feed upon dead animal or plant tissues.

The primary vegetative part of any Fungus consists of fine, colourless threads, containing protoplasm, which branch and penetrate the substance of the host. It is these threads, called *hyphæ* (hy-fee), which dissolve and suck up food. They become matted together in a tangled, compact mass called a *mycelium*. In a mushroom this is known as the spawn. It is usual to propagate mushrooms by planting a lump of this spawn, which, together with the soil containing it, is called a brick.

From the mycelium some threads gather together into a little knob which grows and becomes separated into a cap and a stalk. This is the spore-bearing organ of a mushroom or toadstool, though in other kinds of Fungi it is quite different. The underside of the cap becomes thrown into radiating folds, or gills, and the skin covering the surface of these gills becomes covered with minute spores. The colour of the spores gives the characteristic colour to the gills, which may be white, pink, brown or black. When the spores are shed, they are scattered, sometimes by wind, sometimes by small animals such as squirrels, rabbits, beetles, flies, slugs and snails. The colours and peculiar smells of toadstools may be connected (as in flowers) with the attraction of these creatures.

Fly Agaric Fungus.—This startling toadstool is a brilliant scarlet, flecked with white patches which are remnants of the *universal veil*, as it is called, which enveloped the toadstool in its early stages. A fully developed specimen may be 3-4 in. across, on a thick stalk 6-7 in. high. Smaller specimens are common. In the early stages the enveloping wrapper is like white suede, but as the toadstool swells, it cracks the wrapper in all directions until only the remnants on the cap are left. The gills are further protected—a necessary precaution until the spores are ripe—by a second veil stretching over them from the stalk to the edge of the cap. This is ruptured and hangs down as a white frill on the stalk. This character and the swollen base of the stalk distinguish the fly agaric and

its close kin, all called *Amanitas*, from other toadstools. The name fly agaric has reference to an old custom of obtaining from these toadstools a liquid in which fly papers were steeped. The fly agaric is extremely poisonous, as are many toadstools, and children should be warned against eating any kind of toadstool, for, though some are edible, it is well to err on the safe side. This toadstool is found in pasture fields and grassy banks, and amongst bracken and light woods, such as birch, oak and pine. The spores are white.

Black Inkcap Fungus.—There are many inkcap toadstools, all having in common the habit of dissolving away into a black, inky liquid in which the spores are embedded. When the cap has expanded this deliquescence takes place rapidly. The spores and gills are black or dark purplish-brown, the cap is conical, ragged-edged and wrinkled, with a hollow, silky stem. In the black inkcap the cap is grey, brownish at the centre, and mealy; the stem is white, about $\frac{3}{4}$ in. thick and 6-7 in. long, while the cap is about half as long. The flesh is very thin and the cap is at first pressed straight against the stem. This is a common toadstool near human dwellings, growing generally on rotten stumps and in rich, well-manured ground. The force which is exerted in pushing up from the ground is well illustrated by this toadstool, which is often known to push its way up through asphalt pavements.

FERNS

Ferns are green, non-flowering plants which lead an independent existence and obtain their own food from soil-water and air. They vary in size from minute specimens to tree ferns many feet in height, while their habitats range from water and very damp situations to exceedingly dry sites. They may be found on rocks and stone walls with a modicum of soil. They have a creeping rhizome, sometimes very short, which spreads horizontally and sends down true roots from its lower surface and leaves or fronds from the upper surface. The fronds are folded in a characteristic manner, for they are rolled at the tip like a bishop's crozier. If the leaves are composed of leaflets, these, in turn, are rolled in the same way against the main stem. The leaves may be simple and smooth-edged, as in the hart's-tongue fern, simply pinnate as in the polypody figured on the Plate, or elaborately sub-divided as in the spleenwort, also illustrated. Spores are borne on the underside of the leaves in small hard-walled bodies called *sporangia* (sing. : *sporangium*). The arrangement of sporangia is characteristic in each different fern; they may be on the edges or dotted along the midrib. They are collected together into groups varying in shape, in many cases protected by shield-like outgrowths.

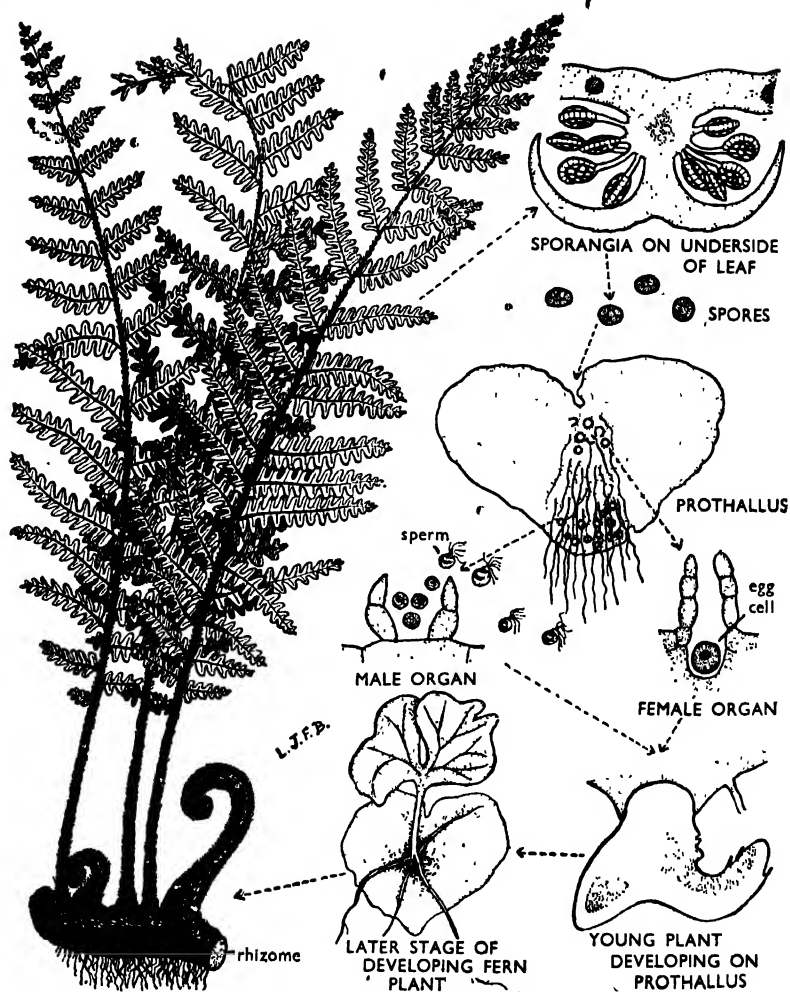


FIG. 31. Life-history of a fern.

When the spores are shed, they germinate in suitable positions, usually requiring a consistently moist atmosphere. From the spore protrudes a tiny green plate which adheres to the soil. It is called a *prothallus* and may be heart-shaped, strap-shaped or more or less circular. From its underside, colourless threads, or *rhizoids*, penetrate into the soil, acting, as do root-hairs, in absorbing water. When the prothallus is established, it produces, embedded in its substance, microscopically small bodies which contain male and female reproductive cells. The male cells are

capable of movement, and dew or rain will supply a means by which they can swim to the female organs. These are like long-necked flasks, having an egg-cell embedded at the bottom. Male cells enter the neck of the flask, and one of them penetrates the egg-cell and fuses with it thus bringing about fertilisation.

The new growth of the fertilised egg is obviously the beginning both of a new individual and a new generation. From the egg-cell grows the familiar fern plant, beginning by forming a single root and one simple leaf, eventually forming the full characteristic fronds and sporangia which bear the spores. Thus the life cycle is complete.

We have here, therefore, the curious occurrence of a life-cycle consisting of two quite different generations, the prothallus plant bearing sexual reproductive cells which unite to give rise to the fern plant with its non-sexual, or asexual, spores. This state of affairs is described as *Alternation of Generations*.

Black Spleenwort.—This is a small fern found on rocks and walls in hilly, limestone districts. Its pinnate leaves are finely sub-divided and bear sporangia along the veins of the smallest lobes on the underside. The sporangia form long, narrow brown ridges.

The illustration of the young fronds shows not only the characteristic rolling, but the presence of numerous brown, scaly hairs amongst the leaves. This is a characteristic condition amongst Ferns generally.

Polypody Fern.—This fern, with its simple pinnate fronds and narrow, strap-shaped leaflets, is one of our commonest species. It is widely distributed both in hilly and lowland situations, on walls and rocks and along hedgerows and waysides amongst other herbage. The sporangia lie on either side of the main vein of each leaflet. They are collected together into circular groups making a single row down each side and are not covered. They are, as in all Ferns, green at first, but brown when mature.

HORSETAILS

The Horsetails represent a remnant of a large group which flourished in early geological times. In the Coal Measures, their kin achieved great size and were extensively distributed, forming swampy forests; in South America to-day there exists one species which reaches a height of 40 ft. Their modest descendants still like damp situations. The marsh horsetail attains a height of several feet, but the much commoner field horsetail is only a foot or so in height, and may be found on relatively dry soil, by a roadside, the edge of a ditch, or scattered over a field.

Each plant consists of a perennial underground creeping rhizome having fine roots growing from it, and also, in the common horsetail, a number of tube-like storage organs. From the rhizome grow barren and fertile branches, called *haulms*. In some species the barren haulms are unbranching, as in the common horsetail. The branching of the haulms is the essential characteristic by which the Horsetails are known, for the branches are arranged in whorls which spring horizontally from the nodes or joints of the stem. Scale-like leaves join to form a sheath or collar round each node, extending some distance up the internode. These fit so tightly that the branches, growing in their axils, have no room to grow upwards and so make their way through by piercing the bases of the leaves. The branches are long, cylindrical and narrow, and have a system of secondary branches, or even a third series.

Spores are borne in cones, not unlike small pine cones, at the top of fertile haulms. In the common horsetail these odd-looking growths appear in early summer before the vegetative haulms; they are striking, bare, flesh-pink structures a few inches high, ending in an oval pinkish knob.

The life-history closely resembles that of Ferns, for the spores give rise to prothallia bearing male and female reproductive cells, and the union of these, in turn, produces the vegetative plant with its non-sexual spores. The rhizome, as in Ferns, is perennial, but the haulms are usually annual growths.

Wood Horsetail.—Height, 6–18 in. The chief distinguishing feature is the branching. About ten fine branches grow from each node. These rebranch at close intervals, giving rise to short, stiff branches which appear to be minutely toothed, but actually have a third series of extremely short branches. They are a vivid green, while the scale-leaves are tinged with pink. The stem, as in all Horsetails, is grooved and there is a wide canal or air-space up the centre.

The cone is borne at the apex of the highest internode of a fertile haulm, which is usually similar to the barren branches. It consists, as in other Horsetails, of a number of special disc-shaped, spore-bearing leaves, called *sporophylls*, specially arranged round the stem to which each is attached by a short, central stalk. The discs fit close together, so protecting the sporangia, which are sac-like bodies arranged on the inner face of each sporophyll between the disc, or shield, and the main stem of the cone. The discs are flesh-pink and the sporangia at first green.

Each sporangium contains a number of green spores of a peculiar structure, for round each spore are twisted four thin, spiral bands, each ending in a small knob. The spiral bands expand in dry weather, but

contract again in damp conditions. They serve the purpose of hooking many spores together, so that they fall in groups. This is important, because the prothallia which develop from them are unisexual, containing either male or female reproductive cells. The device serves to ensure that both kinds of prothallia will be in close proximity, a necessity for fertilisation.

TREES

Introduction.—Trees are plants with woody stems and bark composed of layers of cork replacing the original thin skin. They should be distinguished from bushes or shrubs, for they have a single main stem, the trunk, whereas bushes have several stems rising from the ground. The trunk of a tree gives rise to a number of main branches, which themselves branch many times until they terminate in twigs bearing leaves.

Bark may be thin and smooth, or thick and deeply furrowed in various distinctive patterns. In trees with furrowed bark, the outer layers split as the tree increases in girth, each year exposing a new layer underneath. Though it is not always possible to recognise a tree by its bark alone, this is an important point in determining what kind of a tree it is.

As the shape of trees varies considerably with age and situation, and according to the amount of light received or the amount of crowding by other trees, only a few words can be said here about the shape of each kind, and the description must be taken to refer to a mature, well-grown tree isolated from others. Broadly speaking, in most full-grown trees the main branches originate at about one-sixth to one-fifth of the total height of the tree from the ground, the crown being nearly as broad as long. In the summer, the weight of foliage bends the branches down, so that their free ends are much nearer to the ground than in the winter.

Leaves may be simple or compound. Simple leaves may be deeply indented or lobed. Compound leaves consist of many leaflets, probably originating by the indentations of simple leaves being deepened till they reach the main veins, the stalks of the leaflets being formed by these veins. Compound leaves with leaflets radiating like fingers from a central point are called *palmate*; if the leaflets arise in pairs in a feather-like arrangement on either side of a main stalk (the midrib) they are called *pinnate*.

In most trees the unfolding of new leaves and growth of new twigs is completed quite early in the summer. In the niches, or axils, where leaves arise from the stem, new buds then begin to form. These are usually quite distinct by June or July. They swell up and then acquire a protective outer coat, caused by the hardening of the scales which enclose them. When the leaves fall, these buds can be more clearly seen and their distinctive forms are a great help in recognition. Though they are frequently referred to as "winter buds," it should be realised that they are actually formed in early summer ready for the following spring. The

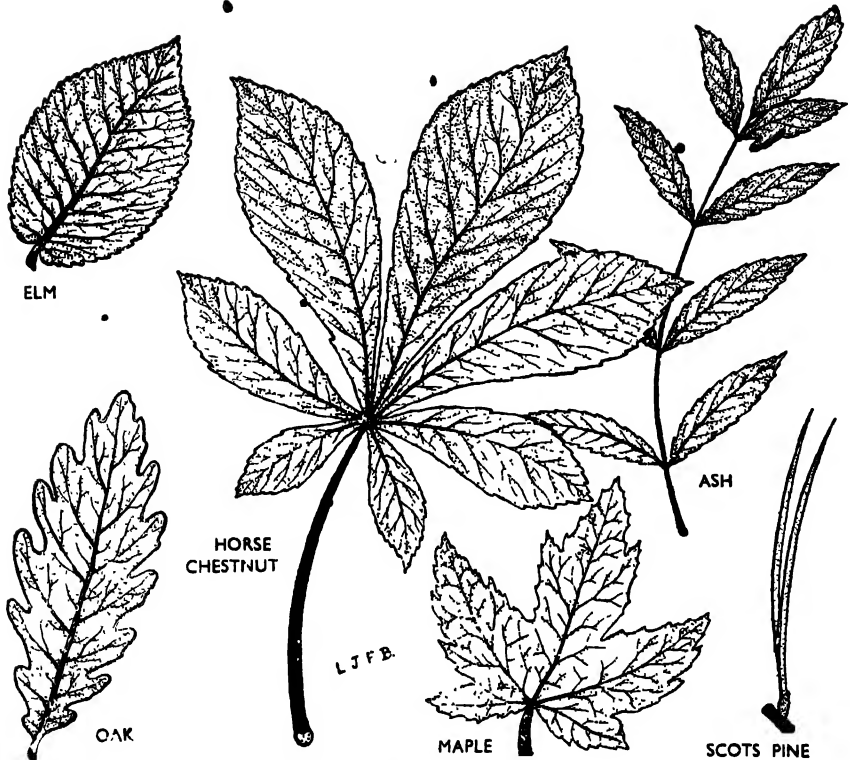


FIG. 32. Types of leaves

same applies to flower-buds where these are distinct from leaf-buds ; for example, catkins.

Though the majority of the trees in the north temperate region are *deciduous*, that is, they drop their leaves in the autumn, some retain them through the winter and only shed them a few at a time after the new leaves have formed. These are called *evergreens*.

Evergreens belong to two main types. Those with small leaves, such as in the pine and fir, are typical of cold climates and exposed situations, arctic or alpine ; that is, high latitudes or high situations. Those with large leaves, chiefly shrubs such as laurel and rhododendron, belong to warm regions of the Mediterranean type and warm foothills such as those of the Himalayas. In all cases the leaves are protected from drought, winds, or excessive heat by their tough, leathery surface.

The cone-bearing trees are a class apart, more primitive than other trees in the structure of their flowers. They are pollinated by wind and

have never developed any petals or other devices to attract insects. In the case of the deciduous trees, which have wind-pollination, these parts are regarded as having been reduced or completely lost.



• PLATE 41. PARTS OF TREES—I

The Oak.—Height, 60–130 ft. The sprig figured on Plate 41 is of the *pedunculate*, or stalked, oak in which the acorns are borne on long stalks. The long, narrow, simple leaves are deeply divided and have practically no stalk. In the sessile oak, on the other hand, the acorns have no stalk but the leaves have a stalk $\frac{1}{2}$ –1 in. long. (There is a picture of the oak on Plate 61.)

Both these oaks are native British trees. Oak woods are common in association with ash on clay soil, and with birch on sandy loams, where they grow most luxuriantly. A massive, closely-furrowed trunk, wide-spreading, gnarled branches, and domed, slightly flattened crown are characteristic of this tree. The lower branches sweep downwards. All the main branches arise close together.

The flowers are of two kinds : (1) slender tassels or catkins bearing little knots of pistillate, or female, flowers and (2) similar but longer streamers of yellow staminate, or male flowers. Some of the female flowers, which appear from April to March, give rise to acorns, not more than two or three from one catkin. An acorn is a nut bearing one seed, enclosed at the base by a cup formed of modified bracts.

The leaves are arranged spirally along the twigs, but crowded in a rosette at the end of each twig. Correspondingly, the winter buds are spaced spirally, but crowded into a cluster at the apex of the twig, ending in one larger terminal or apical bud. The buds are light brown, nearly round but slightly pointed, and covered by numerous minute overlapping scales which are modified leaf bases.

The Beech.—Height, about 100 ft. This is one of our most graceful trees. Its strong, smooth grey trunk gives rise to several main branches, the lower ones sweeping outward and downward to form a canopy ending only a few feet from the ground. The smaller branches tend to spread horizontally, the leaves spreading out so that the foliage forms great triangular layers tapering to a point. The simple, ovate leaves have wavy edges and grow so close together, that they prevent the light from getting through. Consequently, there is little undergrowth, an exception being the bluebells and primroses which fill beechwoods before the leaves unfold. (There is a picture of the beech in autumn on Plate 62.)

Beeches grow best on chalk or limestone soils. When the leaves first

unfold they are light, translucent green, with silky hairs on the underside. They are folded fanwise along the prominent lateral veins. Golden-brown, ribbon-like scales adhere for some time, while the outer scales, which are harder, carpet the ground. These scales are formed from *stipules*, that is, outgrowths from the bases of leaves. (*Stipules* can be seen permanently attached in the case of pea or rose leaves.) The winter buds are long, pointed, spindle-shaped and covered by these stipular scales, which are numerous and closely overlapping.

The two kinds of flowers are not unlike those of the oak, but are clustered tightly together instead of forming loose tassels. Each cluster hangs on a long stalk. They come out in April and May. Two or three nuts are enclosed in a cupule, as in the acorn, but they open by four valves to allow the nuts to fall. The nuts are surmounted at first by the stigmas of the flowers, thus showing that they are fruits, not seeds. The seed is inside each one, as in the acorn.

Leaves and, correspondingly, buds, are arranged spirally, the twigs being slender and close together and making small angles with the stem from which they arise. The twigs are supple and smooth. The bark remains thin, even in old trees.

The Birch.—Height, 50–80 ft. This slender, graceful tree has a deceptive air of delicacy. Actually it can endure extremes of climate and extends farther into the arctic regions in its dwarf form, than even the fir trees, pine trees or willows which all have their low-growing, northern and alpine forms small enough to be protected by a covering of snow in the winter. The birch has a smooth bark, broken at intervals by narrow horizontal excoriations. Its colouring is silvery-white, tinged in parts by golden-brown or faint rose. The simple leaves are almost triangular, pointed, and finely toothed. Their stalks are so slender that the leaves are constantly in movement. Stumpy green catkins form in the summer, and darken to greyish brown as they lengthen to about 1–1½ in. by the spring. They are cylindrical, compact and covered by numerous thin, overlapping scales which loosen to expose the short red stigmas of the female catkins and to let out the light pollen from the males. The pistillate catkins are smaller than the staminate ones. The resultant fruits are minute winged bodies rather like microscopic butterflies. They are dispersed by wind.

The winter buds are small, brown, oval and pointed. They are arranged alternately in the axils of the leaves. The twigs are slender and supple, thinner than beech twigs and dark in colour.

The Elm.—Height, 120 ft. or more. The twig illustrated is that of the common elm or small-leaved elm. This tree has an erect trunk

which, unlike most trees, does not divide into several equal main branches, but continues its growth almost to the top of the tree, giving off branches at intervals, none of them having the girth of the main axis. The common elm does not attain a great breadth, for the tree is not wide-spreading. In this respect it should be contrasted with the almost equally common wych elm, in which the trunk divides into three or four main branches, supporting a wide-spreading, rounded crown. The leaves of the wych elm are twice as long as those of the common elm. (There is a picture of the elm on Plate 61.)

Two other features in the general appearance of the common elm are characteristic. The first is the tendency to produce low down on the bole numerous buds which grow out into bushy tufts of foliage. The second is the tendency to shed branches from time to time, thus leaving great gaps in the elongated crown. The two characteristics together result in giving the tree a ragged, irregular appearance. Many trees shed small twigs in the autumn—a natural pruning or thinning that is useful in admitting air and light—but this habit of throwing down branches is exceptional, though shared by the Scots pine. Amongst country people, this habit has given the elm a reputation for a malicious desire to injure.

The leaves are about 1-1½ in. long, slightly rough, oval and finely toothed. There is a slight point, while the two halves are frequently unequal in size, and in many leaves one side of the base is attached farther along the stalk than the other. This feature is more marked in the wych elm. The elm belongs to the same family as the stinging nettle, and it is interesting to note that the small tortoiseshell butterfly caterpillar feeds on nettles, while its close relation, the large tortoiseshell, feeds on elm leaves.

The flowers appear in very early spring (February and March) and even the fruits are well developed before the leaves unfold. The pale green tufts of oval, winged fruits are sometimes mistaken by casual observers for leaves. The flowers are minute pink cups containing both pistil and stamens; they depend on wind for pollination. Each flower has two prominent stigmas for the reception of pollen, and four or five stamens. The flowers rarely produce fertile seeds.

The winter buds are small, the foliage buds pointed, the flower buds rounder and blunter. They have numerous minute, stipulate scales. The leaves are alternate and the twigs are produced close together so that the crown is dense, having a light, lacy silhouette like a close network. The foliage does not, however, throw a dense shadow as in the case of the beech. The elm is largely used as a hedge tree to provide shelter for cattle, or as a windbreak. It has no heart wood and so decays easily.

The Alder.—Height, 30-40 ft. This tree is generally found by streams or in fairly damp soil where its roots seek the running water. Small roots projecting into the water are pink. A well-grown tree has a long, conical crown, but frequently the shape is irregular and rather ragged. The tree is slender, the lower branches horizontal, the black bark marked by rough scaly patches. The leaves are simple, broad (almost fitting into a square) and slightly indented at the apex, so that they have an inverted heart-shape. The veins are well marked, the margin is wavy and finely toothed like a saw (*serrate*). The leaf-stalks are short.

The winter buds are reddish purple and enclosed in a rough, grooved scale. They fit flat against the twig with the tip curved towards it, so that the shape is like a hand with the fingers close together. Each bud grows on a dwarf shoot about one-eighth to one-tenth inch long. The buds of male and female inflorescences develop during the summer and are visible when the leaves fall. In March and April they grow rapidly and unfold. The staminate catkins, borne on short, branched twigs, hang down; their enclosing scales are dusky crimson, but as they open and the stamens are disclosed, the general impression is of bronze and yellow colouring. The light pollen is wind-borne. The pistillate inflorescences have the form of narrow cones less than one-quarter inch long, composed of numerous overlapping dark red scales, from which protrude pairs of short red stigmas. After pollination, as the seeds develop, the scales of the cone enlarge, becoming green. By the autumn, they are brown, hard and woody. When the seeds are shed the cones turn black, remaining on the tree for at least another year. These small black clusters give a characteristic appearance to the tree and are one means of recognising it in its leafless winter condition.

The Hornbeam.—Height, up to 70 ft. The general form of the wide-spreading crown is rather like beech, and many people confuse the two trees. In other respects there is no resemblance, except that the buds are elongated and light brown in both. Those of the hornbeam are shorter, and the tips of the chaff-like scales fit less closely. The greyish bark is smooth at first, then develops long shallow furrows which frequently show a tendency to twist obliquely round the trunk. Peg-like projections into the furrows make a somewhat ornate pattern.

The leaves resemble those of wych elm, but are smaller. They are a rather narrow oval, drawn out into a pointed apex. The texture is like that of elm, not smooth and hard like beech, and the edge is toothed. The two sides of each leaf are almost equal, though one lobe may be attached to the stalk a little lower than the other. The twigs are slender, like beech.

Both inflorescences are drooping yellowish-green catkins with leafy bracts, and in the pistillate flowers these bracts fall early, their place being taken by three-lobed bracteoles which develop to form three-lobed, shield-like wings, at the base of which the fruits are attached. The fruit is nut-like, flattened and ribbed. The long bunches of leafy, straw-coloured fruits are a characteristic point for recognition. The trees seem to flourish best on clay loam, and are a prominent feature of Epping Forest and other old woodlands round London. The foliage turns rich yellow in the autumn, whereas beech turns to golden-brown and bronze shades.

The Ash.—Height, about 80 ft. Most people agree as to the grace of ash trees, which have a surprisingly slender trunk in consideration of the size of the crown and full masses of foliage they bear. The large leaves, 7-10 in. long, consist of lance-shaped paired leaflets, usually six or seven pairs, and a separate terminal one. The leaflets are serrate.

The trees are often associated with oaks in clay woodlands, but they are also commonly grown as hedge trees. They attain their best growth when solitary, either in hedges or as specimen trees in meadows and parkland. The young saplings are frequently used to strengthen a hedge, as the supple stems can be bent and woven into the structure; the wood is both elastic and tough.

Ash and oak are two of the latest trees to unfold their buds in the spring. The flowers appear before the leaves. They consist of purplish clusters of stamens and greenish-yellow pistils. They may be either together in the same flower or separate, or even on different trees. They cluster rather stiffly along the twigs, looking from below like bunches of short bristles. After fertilisation the fruits develop as the well-known "keys," bunches of them hanging down on stalks several inches long. At first they are green, then pale yellow and, finally, brown. Each fruit consists of a long, light, narrow nut, of which the outer covering is drawn out into a wing. When the fruit separates from the tree and falls to the ground, this wing, which has a central rib and kink like an aeroplane propeller, buoys it up so that it can float quite a long distance on a current of air. When the fruit falls, it spins down in a spiral.

The best time to see the form of the tree is the winter. Then its large triangular black buds stand out stiffly at the end of each twig, buttressed by a much smaller pair, while other very small but similar buds arise in pairs at each flattened node. The nodes (points of origin of leaves and buds) are flattened alternately in opposite directions, and are much wider than the intervening part of the stem, or internode. The skin of the twig is smooth and light grey. Each bud is covered by two full-length, sooty

black scales which meet in the middle. Many of the outermost twigs curve downwards and then up again at the perimeter of the crown. The trunk and large branches have a greyish bark, neatly and regularly furrowed with narrow ridges and shallow grooves.

The Hazel.—Height, occasionally up to 30 ft. Strictly speaking, the hazel rarely has the form of a tree, but is almost always grown as a hedge or coppice bush, which is cut back from time to time, so that it has many equal stems. The broad leaves are rather like those of an alder in size and texture, but there is a pointed apex. The margin is toothed. The buds are green, more or less egg-shaped but a little flattened. They have several small overlapping scales. The flower-buds are larger and more rounded than the leaf-buds, which are slightly pointed. The flower-buds, however, which enclose the pistillate inflorescences, also contain leaves.

The catkins are well developed, though small, by the autumn. Very early in the year, in February and March, they grow rapidly to their full size and open to expose the pale yellow stamens, borne in clusters under the green shield-like scales. In the meantime the pistillate flower-buds open a little, just at the tip, to allow a brush of ruby-coloured stigmas to protrude, and the light, dry pollen is wafted by the wind on to their roughened surfaces. From the pistil and its enclosing leafy bracts grow the nut and its green cupule. Two or three nuts may reach maturity from each bud.

The Lime.—Height, 80–90 ft. The lime is a free-growing, graceful tree. Its limbs are well-spaced, its twigs growing at wide angles with one another so that plenty of light and air reaches all parts. The large, simple leaves have a peculiarly translucent, delicate texture, though they darken, like most leaves, in full summer. They are broad at the base and drawn out into a long point at the apex. The stalks are slender and the margins delicately serrate. Tiny tufts of white hairs along the underside of the midrib are noticeable.

The flowers open rather late—in June and even early in July—after the leaves are fully expanded. They grow in small clusters—up to five or six—on a long, branching stalk, subtended by a narrow, leaf-like bract which later serves as a wing. The clusters hang down below the leaves and are quite conspicuous by their light straw colour against the green. They further make their presence known by an overpoweringly sweet smell, announcing that there is abundance of nectar in their shallow flower-cups, a fact soon discovered by bees. Indeed, it is not unknown to see bees, drunk with the nectar, lying helpless on the ground under the trees. The flowers give rise to small nut-like fruits which are borne away by the wind on the bract parachute. Like the ash fruits, they make a

spiral descent. One to five fruits may develop from one inflorescence—two to three are the most usual number.

The winter buds are easy to recognise; they are oval with a slight hump on one side and a pointed apex. They lie close against the stem but pointing outwards, and are frequently red in colour, or red on the outer side and green on the inner, with two ensheathing scales and usually a very small one at the base. The wide spacing of the twigs allows each bud to be clearly seen against the sky.

The bark of the tree is greenish-grey or dark grey, liable to be covered by a film of green algæ, such as is often seen on wooden railings. It is smooth at first, later breaking up into long rectangular patches with slight furrows. These patches again crack horizontally, so that an irregular pattern of flat scales results.

PLATE 42. PARTS OF TREES—II

The Sycamore.—Height, 60–80 ft. This is a quick-growing tree, attaining full height at about fifty years old, which is young for a tree. The sycamore is one of the maples, having the characteristic five-pointed simple leaf. It is a strongly-built, sturdy-looking tree with dense foliage, the leaves forming a mosaic pattern as a result of the inclining of the stalks, which exposes as many leaves as possible to the fullest amount of light. Leaves at lower levels occupy the spaces left between those which are higher. The bluish-grey bark is dotted with small dark marks (the breathing pores or lenticels) and roughened slightly by horizontal lines or, in the case of young bark, by irregular circular outlines. On the older trunks the bark breaks up into scaly patches, following no regular course, though there is a suggestion of vertical cracks. (There is a picture of the sycamore on Plate 62.)

The appearance of the tree in winter is more solid than most trees, as the twigs are thick, and the large oval buds terminating the twigs give the crown a clipped look against the sky. In the case of flowering twigs, the flower-buds of each year give rise to fruits which fall away, leaving a gap in place of a terminal bud. The two buds immediately below, also flower buds, enlarge to take over its function. This arrangement may also be noticed in the horse chestnut, which has a similar growth. The buds below the terminal bud are arranged in pairs, those at each node growing at right-angles to the pair above and below. The buds are green, and covered with a series of overlapping scales arranged in the same way as buds and leaves, for they are in reality modified leaf-bases which have developed no blade. Occasionally, both in sycamore and horse chestnut,

the unfolding buds in the spring show a miniature leaf blade developing on one or two leaf-base scales, especially on shoots developed from dormant buds at the base of the trunk. This is an interesting occurrence for children to look out for, since it shows how bud-scales may have developed from ordinary foliage leaves, and suggests how leaves have arisen from simpler forms.

The flowers develop after the foliage is expanded. The inflorescences of saucer-shaped, green flowers hang down in loose tassels or racemes, 3-5 in. long. Winged fruits are produced in pairs, sometimes in threes, from each flower. These separate and on windy days are borne away on the air for some distance. Each seed is enclosed by a fruit wall drawn out into a wing shaped somewhat like that of a dragon-fly, narrowing to a slender neck close to the seed and widely expanded at the free end. This is supported by veins, with a specially rigid vein along the outer edge serving as a pivot, round which the wing sways, weighted by the seed. Here again a spiral movement takes place. It is interesting for children to watch and compare the different methods by which winged fruits "fly."

The White Poplar.—Height, 60-100 ft. if fully grown, but more usually seen as a garden tree of only 30 ft. or so. This species is regarded as one of our two native poplars, the other being the aspen. The bole of the tree is whitish-grey marked by numerous short horizontal black ridges—dots and dashes. These are corky eruptions of the smooth bark, following the lines of the lenticels. The lower part of the trunk becomes furrowed vertically. There is a certain resemblance to birch in the bark, but there is not the variation in colour and it looks stronger, while the markings are bolder and closer together. The leaves are ovate, or almost heart-shaped, coarsely toothed and sometimes jagged, especially if they grow on offshoots or suckers from below ground level—a frequent condition. Underneath they are white and cottony; as the wind blows, these white undersides are exposed, giving the whole crown a silvery appearance. The upper surface is dark green. The leaf-stalks are long and flattened from side to side, so that the leaves are moved almost as much as in the aspen, which is noted for its shivering leaves.

Staminate and pistillate flowers are borne in separate catkins and on separate trees. The large staminate catkins are a wonderful sight in spring, about four inches long and nearly half an inch thick, with bright pink to crimson scales and long purple stamens. These drop off and lie thick on the ground after the pollen is shed. The shorter pistillate catkins of course remain on the tree until the seeds are ripened. The fruits are small capsules which open to expose plumed seeds like those of the willows. The whole catkin at this time appears to be a tangled downy mass.

The winter buds, too, are cotton-lined. They are small, pointed and inconspicuous. The whole tree, either in summer or in winter, has a light, graceful appearance, greatly enhanced in the summer by the shimmering foliage.

The Aspen.—Height, about 40–80 ft. This is a smaller tree than the white poplar and, like its relations the willows, is liable to early decay from the fact that it has no heart wood. This is true of all poplars, but the aspen is one of the least durable. Both poplars and willows are amongst the trees ravaged by the goat moth and wood leopard moth. The leaves are smaller than those of the white poplar and broadly ovate. They have a longer stalk, compressed in the same way, so that they dance and flutter in the slightest breeze. One variety is downy beneath, the other almost smooth. The aspen agrees with the white poplar in its flowering and fruiting, but has smaller catkins. Both trees, like all poplars and willows, thrive best on moist soil.

The Scots Pine.—Height, up to 100 ft. This was originally a native tree, but in nearly all cases, except in parts of the Scottish Highlands, it is found only in plantations or planted in single rows and small groups as windcreens. The Scots pine bears its dark tossing crown at the top of a long, bare trunk, having only a few short branches. In the early stages of growth it is pyramidal with layers of foliage borne on branches which grow in circles, more or less equidistant, and diminishing in size to the top. As growth proceeds, the branches bear fewer and fewer leaves close to the trunk, and from time to time whole boughs are shed, leaving irregular gaps and ragged tufts of foliage. (There is a picture of the Scots pine on Plate 61.)

The leaves are crowded on the outermost twigs and have the appearance of bottle brushes. They are arranged in so close a spiral that they appear to be in circles, and they grow in pairs on diminutive shoots, perhaps one-eighth inch long. Each pair of needle-like leaves is grooved on the inner side where the two leaves face each other, and is convex on the outer surface. They are two to three inches long. Their dark green colour is lightened in young leaves to a bluish-grey by a covering of fine bloom. The leaves are evergreen. Very large buds covered with brown scales terminate each twig. The beautiful, straight bole is boldly furrowed in broad, irregular patches, cut transversely by short grooves. The colouring is extremely varied when the sun shines on it—gleaming purple, crimson and gold on the darker, brownish background. There is a delicious resinous smell in the sun's warmth.

In early summer the Scots pine bears stumpy spikes of pale yellow stamens tightly packed together, which scatter clouds of very light, winged

pollen-grains. The whole mass may be one and a half inches long and nearly one inch broad, though each spike is only about a quarter inch long.

Pistillate flowers, which are borne on the same tree a short distance away, consist of small pink cones made up of scales bearing ovules on their inner, or upper, face—that is, towards the apex of the cone. After pollination these cones become green, then light brown. They take eighteen months to develop the seeds, and, in the meantime, the fleshy scales of the cone become woody and develop a diamond-shaped boss on the outer end. These bosses fit closely together shielding the developing seeds completely. When the seeds are ripe, the scales separate and allow them to drop out. The seeds are winged and wind-dispersed. The cones, which reach a length of about two inches, are broad at the base, tapering to a point.

The Sallow.—Height, up to 30 ft., more usually about 20 ft. The willow or salley is the small willow also known as palm willow. It is more usually a bush than a tree. The bare stems are golden bronze in winter and the tree is a lovely sight in early spring before the leaves unfold, when it glitters with either gold or silver, according to whether it is a stamen-bearing or pistil-bearing shrub. Like the poplars, the willows bear their stamens and pistils in different catkins on different plants. These golden or silver blobs need little description, for they are familiar to everyone. In both, small scales clothed with silky hairs bear the flowers. Each scale bears either stamens or a pear-shaped pistil with two stigmas. At the base of the scale is a tiny nectary which attracts hosts of bees to this first honey-harvest of the year.

The supple twigs, dark near the base but light golden-brown or reddish at the periphery, are useful for basket-making, for they are tough and pliable but difficult to break. The short egg-shaped leaves are greyish-green, usually downy beneath and variable in shape and size. The bush is certainly most attractive when in flower, for later its appearance is rather dull until the cottony seeds make their appearance, when the small capsules open to disperse them.

The Yew.—Height, up to 50 ft. This is a native tree found particularly in the woods of the chalky Downs and other limestone districts. It grows to its best proportions as an isolated tree and good specimens are frequently found in churchyards. The extremely slow growth renders the wood tough and durable. For the same reasons that oak was grown and esteemed in the old days for the ships of the Royal Navy, so the supple yew was cultivated for the long bows of the English bowmen. As the tree grows it gives off spreading horizontal branches a few feet from the ground, and the dense foliage throws deep shade. Later, other

offshoots appear at ground level and, growing up close to the trunk, fuse with it, so that the trunk appears to consist of a deeply fluted column. The reddish bark peels off in large flakes and in an old tree the whole of the wood of the trunk is exposed.

The narrow, strap-shaped leaves are arranged in two rows close together on the twigs, which thus have a feather-like appearance. The Irish yew, however, which is also a favourite churchyard plant, as well as a subject for the once popular fantastic clipping, has its leaves spirally arranged, so that they stick out spikily in all directions. The leaves are so dark as to be almost black. There is no doubt that yew trees reach an age of several hundred years, though whether it runs into thousands is open to question.

The pistillate and staminate flowers are borne on different trees very early in the year. The staminate inflorescences are like those of the pine but in separate groups, each having only five or six yellow anthers. The inflorescences are found on the underside of the twigs and each is nearly round. They produce clouds of dry, light pollen. The pistillate flowers are small and inconspicuous, each consisting of a fleshy disc bearing a single ovule or egg-cell, partially protected by a few small scales below the disc. These naked or exposed ovules are characteristic of the groups of plants known as *Gymnospermous*, a word meaning "naked seed," to which both pine and yew belong. The higher plants all have their ovules enclosed in an ovary. When fertilisation of the ovule has taken place, the green disc swells up and embeds it, turning bright scarlet like sealing-wax and thus forming the so-called berry, which does not, however, completely enclose the seed as does the ovary wall in a true berry. The berries of yew are not poisonous, but the leaves are.

The Holly.—Height, up to 40–50 ft., though more usually a small tree or shrub of from 20–30 ft. The holly still grows wild in many parts of the country. Many bushes never have berries owing to the fact that frequently pistillate and staminate flowers are on different plants. The small cream-white flowers have four perianth leaves, four stamens, or a pistil with four stigmas. The flowers grow in clusters in the leaf-axils and have very short stalks. The place of the pistillate flowers is taken by the bright crimson "berries," which ripen through the summer and are mature by September and October. They are not really berries but *drupes*, like the plum, except that instead of having one stone containing a kernel or seed, they have four. (There is a picture of the holly on Plate 61.)

The bark is light to dark grey, smooth but broken on the trunk by "dots and dashes," as are so many smooth barks. The glossy evergreen

leaves are tough and hard, and usually drawn out into a number of sharp points at the margin which is curiously waved, forming a number of channels which may be useful in allowing rain or snow to run off. All these features, including the spines, are primarily connected with protecting the tree against loss of water-vapour through the leaves. This is the case with all evergreens in which the leaf surface remains exposed through the winter, when the roots are physiologically incapable of taking up much water. It may be that, as a secondary advantage, the spines also protect the tree against grazing animals, but this is of much less importance.

The Spindle.—Height,* at most, about 20 ft. The spindle rarely develops as a true tree, for even when it attains full height it is most likely to have two or three slender main stems of equal girth. It is usually found in hedges or coppices on limestone soil, and is fairly common in the south of England on the chalk Downs, Chiltern Hills and outlying districts, and parts of the West Country and Wales. In the North and in Scotland and Ireland it is rarely seen, though it appears to be a native plant. The slender stems are grey or dark green, the twigs are green and four-sided, and both twigs and leaves are paired. The leaves are lance-shaped and finely toothed; some of the lower ones may be oval, when they are difficult to distinguish from buckthorn, which grows in similar places—in fact, they are often found in the same hedge. In buckthorn, however, the leaves are *not* paired, but spirally placed, while the similar green flowers have shorter stalks which do not branch. The flowers of spindle are like tiny pale green stars, with four sepals, four petals, and four stamens. The flowers may be either staminate, pistillate, or combined. They are borne in the leaf-axils.

Many people who never notice the spindle in the summer are attracted to it in the autumn by its changing red and yellow leaves, and by its curious bright, coral-pink fruits, divided into three to five lobes, each containing a seed. The fruits, which are not berries but capsules, open to reveal the bright orange seeds, rather like those of the yew berry. The orange coat is not part of the fruit wall, but a separate structure.

In addition to the interesting and beautiful fruits, the spindle is of interest because its name is due to the former use of the wood for spindles for the home spinning of wool and flax.

The Juniper.—Height, up to 10–12 ft., but usually a low-growing evergreen shrub, the berries of which are used in the manufacture of gin. The juniper may be seen as a slender pyramidal tree in low-lying situations. It is found growing freely on the North Downs on chalky exposures, either as the undergrowth amongst woods or forming a kind of scrub much like gorse. It is very prickly and closely resembles petty whin, the small-

leaved furze, but it is quite unlike a furze in its flowers and fruits. Except that it is prickly, it is much like yew, to which it is related. The leaves, which grow in whorls of three, are like spines. The inflorescences consist of small staminate catkins like those of yew, with clouds of dry, light pollen; and small bud-like pistillate cones, consisting of several fleshy scales. From the upper ones blue-black berries are formed, rather like bilberries, with a whitish bloom. These cluster in the axils of the leaves and are produced profusely. They take over a year to ripen. Pistillate and staminate inflorescences are on different plants, as in yew.

PLATE 43. PARTS OF TREES—III

The Purging Buckthorn.—Height, 5–10 ft. This plant occurs either as a shrub or a small, slender tree. It has no very conspicuous features and does not attract attention. Its berries used to be valued as a purge or cathartic in the belief that the more violent and griping the action, the more effective was the medicine. It had, however, so strong an action as to be injurious and has consequently fallen into disuse, though the milder syrup of buckthorn is still sometimes used.

The tree has dark green, egg-shaped leaves, finely toothed. Small, green, four-petalled flowers appear singly or in clusters in the leaf-axils, to be followed by dull black berries. The leaves can be distinguished from dogwood, which they somewhat resemble, by the presence of teeth and by the absence of gorgeous autumn colouring. They are broader and more oval than spindle leaves. Many short twigs are developed as spines.

The Blackthorn.—Height, up to about 20 ft., but more generally found as a hedge bush than as a tree. The blackthorn makes an impenetrable hedge with its bristling, spiky twigs pushing out in all directions. Most of the twigs end in formidable spines. The black bark throws up the whiteness of the numerous five-pointed flowers which clothe the twigs closely in February before the leaves open. The flowers have short stalks, so that they lie close to the twigs, singly or in twos and threes, a different arrangement from that of the whitethorn or hawthorn with its large umbels. The fruits, usually known as sloes, are purplish-black with a fine waxy bloom which is easily rubbed off. The blackthorn or sloe is our most common wild plum and is found all over the country. Country people make wine from the fruits, which are also used in sloe gin.

The Strawberry Tree.—Height, usually 10–12 ft., but may attain 20–30 ft. in cultivation. This is a native of Ireland where it is still found

wild, but it is not indigenous to Great Britain. This attractive little tree is chiefly known for its strawberry-like fruits, which may be seen on the tree at the same time as the drooping racemes of creamy heath-like flowers, owing to the fact that the fruits take more than a year to ripen. There is no botanical resemblance between the fruits and true strawberries. The tree has twisted, scaly, reddish bark, and oval, leathery leaves two to three inches long, toothed at the margin and with hairy stalks. Short internodes at the ends of the twigs cause an appearance of rosettes of leaves, as in oak. The flowering season is in autumn.

The Hawthorn.—Height, up to 40 ft., but more usually 10–20 ft. This is our commonest and best-known hedge bush, and the name is said to be derived from the Anglo-Saxon word for hedge-thorn. Whitethorn is another name. On windswept open spaces it bends and grows in the direction pursued by the prevailing wind. Left to its own devices on open land such as rough pastures, it sends out numerous suckers and these, together with seedlings, will soon convert a field into dense thicket. The trunk (if a tree) and branches are slender, the branches twisted and rugged. The bark is hard, rough and scaly, ash-grey or light brown. The small, simple leaves are deeply notched into five or more narrow lobes. They change from dark, glossy green, to burnished yellow, orange, purple and red in the autumn. The inflorescences are simple umbels of shallow cups, each having five small pointed sepals, five concave petals, and twenty to thirty stamens, the changing colour of which, varying from pale pink through yellow to dark brown, indicates to visiting insects whether they are immature, ready for pollination, or spent. There is a heavy, almost overpowering, sweet scent. The parts of the flower are all attached to the rim of the hollow receptacle in which the ovary is embedded, the stigmas protruding from the narrow opening. After fertilisation this hollow closes, and the receptacle turns from green to crimson and becomes much larger; the so-called berry is very attractive to birds and is dispersed by them.

The Mountain Ash.—Height, 30–50 ft. This is a hardy, graceful and attractive tree. It will grow on poor or scanty soil, at high altitudes and far north. In Great Britain it is associated particularly with outcrops of rock in the more mountainous parts, where it grows in crevices, partly sheltered perhaps by the wall of a ravine. It will also grow to greater size beside streams. The smooth, light grey bark is marked with narrow horizontal lines of corky thickening, as in birch, cherry, white beam, holly and white poplar. The bark remains quite thin, though it may become thicker and irregularly furrowed near the base.

The slender branches and twigs bear long pinnate leaves, of the same

type as the ash but smaller and of more delicate texture ; the leaflets are narrow and finely serrated. They turn to beautiful tawny, lemon, crimson and scarlet shades in the autumn, when they make a wonderful sight against a background of grey rocks, especially with the heavy clusters of blood-red "berries." These are not true berries but resemble apples in structure, the tree belonging to the genus *Pyrus*, which includes apple, pear and whitebeam. The inflorescences are large creamy clusters resembling hawthorn, though with flowers of only about half the diameter. The berries make an excellent jelly. In folk-lore, branches of rowan (an alternative name) are regarded as having magical properties, in particular, protecting against evil influences.

The Dogwood.—Height, 6-8 ft. This is a hedge shrub found more commonly in the southern and western parts of Britain than in the northern, and often in association with spindle and buckthorn in copses and hedges. It is a pretty shrub, with reddish or orange-coloured stems and boldly-veined ovate leaves with smooth, sometimes wavy, margins. Starry clusters of small white flowers grow from branching stems in the axils of leaves. The leaves are in pairs. In the autumn, glossy black berries are in striking contrast to the flaming tints of the leaves. Young twigs of one year's growth are green.

There is no reason to confuse it with privet, as some people do, for privet has narrower, smoother leaves, not indented by the veins, of harder texture and retaining their dark green colour at all seasons. In privet the inflorescences are short, stiff racemes with a heavy, sickly scent, instead of being in rather flattened clusters as in the dogwood.

The Wayfaring Tree.—Height, up to 20 ft. but usually about 6-10 ft. This too, is a hedge shrub, probably never truly to be called a tree. It has several slender but exceedingly tough main stems, from which branches are given off in pairs in the axils of leaves, which are also, necessarily, paired. The growth is thus formal in pattern yet extremely graceful, particularly as the well-spaced, colourful leaves, which are spread horizontally, are large and heart-shaped, with a pointed apex. They have a thick, flannel-like texture with a mealy surface due to a coat of short hairs on both sides. The veins are strongly marked and the margins toothed. Their light greenish-grey colour changes in the autumn to shades of flame, greenish-bronze and reddish-purple. Dense slightly rounded umbels of white flowers give place to oval berries, slightly flattened at the sides, with a pointed tip. In July these are coral-coloured, but they gradually change to glossy black. The mixture of black-and-red berries in one cluster at a certain stage has a bizarre effect. The inflorescences resemble those of the dogwood, but are broader and more compact.

In winter, the wayfaring tree is still colourful and attractive in form, for the purplish or reddish-brown stems bear grey winter buds stiffly held upright against the stem, like praying hands, while at the summit of each twig there is a flattened coronal—the flower-bud for next year. The scales protecting the buds are small foliage-leaves, in which the midrib and blade can be clearly discerned. The shrub flourishes on dry soil and is especially characteristic of chalk.

The Elder.—Height, up to about 20 ft. This quick-growing shrub or small tree is associated with rank soil and coarse wayside plants. It is generally credited with draining the soil of nourishment so that other plants cannot grow there. The branches and twigs have a centre of soft pith which can be easily extracted, leaving a hollow tube or pipe. The bark is thin, grey or greenish, and corky. The large pinnate leaves have five or seven long, toothed leaflets, light green or yellowish-green in colour.

There is one moment of the year when the elder may be considered really decorative, that is when a well-grown tree or bush, especially the variety with variegated leaves, spreads its large, flat inflorescences of cream-coloured flowers against the background of its foliage. There is a certain grace about the inflorescences, each with a main stalk dividing into five smaller stalks which branch again, bringing all the tiny flowers to the same level. The florets are short tubes spreading out into a five-pointed disc, and the long filaments bring the anthers beyond and between the petals. The pistil gives rise to a soft, juicy berry, and the weight of the berries frequently drags the head down. Many birds are fond of the sickly-sweet berries, and presumably insects enjoy the heavy, sweet odour of the flowers. Both flowers and berries are used by country people for concoctions, the flowers for a tea, and the berries for wine.

The Guelder Rose.—Height, about 12 ft. This willowy shrub is to be found in damp coppices and hedgerows, usually supported by other trees. It is a close relation of the wayfaring tree, but has none of its sturdy toughness of appearance. It is more delicate in texture in all respects—leaves, stems and berries having a more fragile look. The inflorescences are similar, but in the guelder rose the outer florets are larger than the central ones and are sterile, serving by their large size and conspicuous petals to attract insects to the fertile florets, which further draw attention to themselves by secreting nectar.

The leaves of the guelder rose are thin and not hairy; they are divided into three to five lobes and the margin is toothed. The stems are weak-looking and smooth, the younger ones being purplish-red in colour. The almost globular berries are a lovely translucent ruby and have the same texture as red currants.

PLATE 44. PARTS OF TREES—IV

The Sweet Chestnut.—Height, 60–80 ft. in good conditions. This tree, probably introduced into Britain by the Romans, is found over great parts of Europe and especially on hillsides round the Mediterranean and in the Midi. It is also much planted as a woodland tree in parts of southern England and grown in coppes to cut for fences and hop-poles; for example, in Kent. Its fruits, or nuts, do not grow to any great size in Britain, though they may be edible.

The tree is very handsome with a tall, domed crown reaching almost to the ground and rich, heavy, bright green foliage. The trunk is covered by deeply-furrowed bark which sweeps round it in long spirals; the larger branches are also furrowed and the smaller ones smooth.

The simple, lance-shaped leaves are four or five inches long, glossy, toothed and deeply veined. The inflorescences are catkins, six inches or more in length, consisting of both pistillate and staminate flowers and growing in the axils of leaves. Near the base of the catkin is a group of two or three pistillate flowers enclosed by four prickly bracts forming an involucre, which afterwards becomes the well-known cupule enveloping the nuts. Each flower consists of a pistil with a slender style divided at the tip into five to eight stiff, radiating stigmas and enclosed by a small green perianth. The stalkless staminate flowers occupy the free-swinging axis of the inflorescence along its whole length and are spaced at regular intervals. Each staminate flower consists of several stamens enclosed in a green perianth. When pollination has been effected by the agency of wind, the staminate portions of the catkin drop off and the ground under the tree is covered with them. The pistillate flowers remain, and from each pistil develops a glossy brown fruit enclosing one seed, which still retains its spiky stigmas until almost ripe. As several fruits are pressed together, they grow rounded on the outer side but flat on the inner surface. The cupule of bracts also enlarges, its prickles become longer, and inside it develops a fine silky lining. For a long time it is light green, but by the time the fruits are ripe it has become a pale straw colour.

The sweet chestnut is lime-shy, that is it cannot tolerate lime, so though the tree is frequently found growing where the underlying rock is chalk or limestone, it is only where local gravelly or sandy deposits have accumulated.

The Horse Chestnut.—Height, 80–100 ft. This tree is supposed to have been introduced to this country from the East about the year 1556. The origin of the name is uncertain. The popular idea that the tree had

any value as a cure for horses cannot be supported, neither can the notion that the name is connected with the horse-shoe shape of the leaf-scars.

The only resemblance to the sweet or Spanish chestnut is that the seeds of the horse chestnut are much the same size and colour as the nuts of the sweet chestnut. The enclosing, prickly capsule of the sweet chestnut is composed of bracts, while the spiky green coat of the horse chestnut is the fruit wall, or *pericarp*. The glossy brown layer is the pericarp in sweet chestnut, but it is the seed coat or *testa* in horse chestnut.

This well-known tree raises its handsome crown from a trunk which divides at a low level. (There is a picture of the horse chestnut on Plate 62.) The foliage is disposed in large masses with heavy shadows. The twigs are thick and strong, bearing leaves in pairs at thickened nodes, each pair being at right angles to the ones next to it. The greatest growth each year comes from the terminal buds, which are much larger than the side or lateral buds. The umbrella-like leaves may be as much as ten inches across. They consist of seven to nine long leaflets meeting at a central point where they join the leaf-stalk. The leaflets are broadest near the free end; they then narrow down gradually to the point of attachment. They are toothed, and the veins are strongly marked. The inflorescences are large, upright pyramids of pink or cream and crimson flowers, in the form of racemes. They are pollinated by insects.

The large, egg-shaped winter buds are covered with glossy, resinous brown scales arranged in overlapping pairs. Immediately below each lateral bud there is a shield-shaped leaf-scar, clearly marked with leaf traces round the edge, where the veins entered the leaf, the number corresponding with the number of leaflets. The twigs have a smooth brown skin, while the larger branches are covered with smooth bark, slightly broken by fine cracks. The trunk has scaly bark with irregular, flat patches.

The Plane.—Height, 70–90 ft. This is not a native, but has acclimatised itself here, especially in smoky towns where it grows better than most other trees except, perhaps, black poplar. The plane is particularly successful in London. It is a handsome, widespreading tree with a rather slender trunk and deeply lobed leaves not unlike sycamore, but tougher in consistency and glossy. The leaves can always be definitely recognised by one feature—the base forms a hollow cap which fits over the axillary bud, so that while the leaf is on the tree the bud cannot be seen, and when the leaf falls, the hollow base is distinctive. The bud is cone-shaped and green, with one scale which completely encloses it. The bark of the tree, too, is distinctive. It is smooth, light grey (but darkened by soot in

towns), and each year large patches flake away, leaving the new pale yellow bark exposed. This bark gradually darkens.

The male and female inflorescences consist of long, slender stalks with clusters of flowers in the form of pom-poms spaced at intervals. The pistillate inflorescences retain this form as they gradually ripen into fruits, the balls being of all sizes up to one inch or more in diameter. These pretty tassels are another distinctive characteristic of the plane.

The Walnut.—Height, up to 60 ft. This is another tree which has come to us from the East. It has a wide-spreading crown and slender trunk, with dense, dark green foliage. The pinnate leaves are smooth and thick, almost leathery, consisting of five or seven leaflets which are broadly ovate with a smooth margin. The buds are small, the twigs slender. The flowers come out before the leaves; the staminate flowers are in long, narrow catkins, while the pistillate flowers grow at the end of the shoots either singly or in small groups. Both kinds of flower have a green perianth, enclosing either numerous stamens or an ovary with two or three fleshy green stigmas. The fertilised ovary develops into the so-called nut, really a drupe like a plum, of which the nut-shell is the stone and the nut is the seed or kernel. The smooth green outer coat corresponds to the flesh of the plum.

The bark of an old tree is deeply furrowed, though in younger trees it is a smooth, medium grey. The tree grows fairly quickly, so the wood is coarse, yet it is much valued for furniture and for the butts of rifles because of the attractive grain. Both leaves and fruits contain a juice which turns to a dark brown, persistent stain.

The Laburnum.—Height, about 20 ft. This slender, graceful little tree is grown for its decorative effect, and especially for its flowers of "golden rain." It belongs to the mountains of southern and central Europe, and is not found wild in Britain, though it is completely acclimatised. Its bark is smooth, only slightly broken by horizontal markings, and grey or greenish-grey in colour. The pale green leaves are tri-lobed. The drooping yellow racemes of pea-like flowers are succeeded by silky green pods, which ripen and split to release the seeds. Children should be warned against eating either pods or seeds, which have violent and dangerous emetic properties.

The Bay.—Height, generally up to about 20 ft., though a fine specimen may reach 60 ft., when it would usually, however, have several stems produced as suckers in addition to the original trunk. The bay is grown as an ornamental tree or shrub and for its aromatic leaves which are used for flavouring many dishes. It is a native of southern Europe, and is not quite hardy in Britain except in the south. Its glossy, lance-shaped

leaves were used for the crowns of honour in ancient Greece and Rome—bay or laurel leaves. They have a slightly irregular but smooth margin, and very short stalks. They grow alternately on short twigs, very close together, those at the tip being much larger than those lower down the twig. The inconspicuous, four-pointed flowers are of two kinds, staminate and pistillate, and are on different trees. Large purplish berries ripening in October are produced from the pistillate flowers.

The Silver Fir.—Height, up to 200 ft., but in this country only 100–120 ft. This is a native of the forests of central and southern Europe. Like the Scots pine and larch it is conical in form, its straight trunk tapering gradually and the crown also becoming gradually narrower towards the top. Like them, too, it tends to lose the lower branches as it grows older, peg-like projections showing their positions. This takes place after forty to fifty years, while its life is said to last about four hundred years. As the tree grows older, the crown spreads and becomes flat-topped.

Firs differ from pines in the arrangement of the leaves, which are in two or three rows close together along the twigs, giving a flat or almost flat, feather-like appearance. In the silver fir they are about one inch long, dark rich green above and silvery underneath. They last from six to nine years before falling off.

The inflorescences resemble those of the Scots pine, and are formed at the tips of shoots. The mature cones are cylindrical, of almost the same diameter throughout, rounded at the tip and six to eight inches long. They are light brown, with flexible woody scales (not thickened into bosses as in pines). As in the Scots pine they take eighteen months to mature. They produce winged seeds which are not shed till the following spring after reaching maturity. The free edge of the scales is rounded, which distinguishes it from the pointed scales of spruce. The smooth bark of the young trees becomes furrowed longitudinally as the tree grows older, whereas the bark of spruce has a scaly appearance. Silver fir does not produce durable timber.

The Larch.—Height, usually 80–100 ft. This is a native of European alpine forests but is grown in Britain, and especially by the Dukes of Atholl, as a useful timber tree and now occupies many acres in our hilly districts. It has the distinction of being a *deciduous* cone-bearing tree, that is, it drops its leaves in the autumn. Most other conifers are evergreen. The needle-like leaves are a lighter green than those of the evergreen conifers and they grow in tufts from very short dwarf shoots. These shoots give a notched appearance to older twigs which no longer bear leaves, and so form one of the distinctive features of the tree. (There is a picture of the larch on Plate 62.)

Early in the spring, before the leaf-buds unfold, the pistillate cones may be seen. These are a bright ruby colour, slightly larger and much brighter than those of the Scots pine already described, but similar in structure ; clusters of small staminate catkins occur at the same time. The pistillate flowers develop into light-brown cones about one inch long, considerably smaller than those of the Scots pine. The scales remain uniformly thin and, though woody, quite pliable. The shape of a solitary, well-grown tree is conical, with whorls of branches beginning at a low level. Where trees grow in plantations, the lower branches do not have a chance of developing and are no more than under-sized twigs, while a bushy crown surmounts the long, straight trunk. The bark is evenly patterned with large, flat, scaly patches.

The Spruce Fir.—Height, up to 150 ft. This is a valuable timber tree native all over Europe in the higher lands, but introduced into Britain, though there is evidence that in pre-glacial times it was a native here also. Its baby stage is the Christmas-tree. The growth is regular in pattern, with a projecting terminal spire, not a bushy crown as in silver fir. The leaves are shorter and grow more densely. The bark is scaly, not furrowed in old age. The cones are similar, but those of the spruce *hang down*, while those of silver fir *stand up*. In spruce they are slightly pointed and a little shorter, about five and a half inches long. Each scale has a larger area exposed, is pointed, and has a narrow projecting out-growth down its centre. Spruce is largely used for paper pulp as well as for masts and scaffoldings, and it supplies resin and pitch. The warm resinous smell of a spruce forest on a sunny day, like that of a pine forest, leaves a memory that brings back in its train all the essence of a mountain holiday.

INSECTS AND OTHERS

Insects probably outnumber in species all the rest of the animal kingdom. The total number of species already known to science is half a million and there are probably as many more that remain to be discovered. It is estimated that there are eight million specimens in the collection at the British Museum and this collection is incomplete. The great numerical preponderance of insects is to be ascribed to their extraordinary adaptability to live under the most diverse conditions, and especially to the possession of wings.

It is thought that somewhere amongst the lowly members of the group of worms a divergence of form took place, which resulted ultimately in the development of very highly organised races of animals which spread from water to land. Man and the birds represent the highest points reached by the vertebrates, and insects the highest point of the invertebrates. These highly organised animals mastered not only the habitable land, but also the air.

If an animal is to achieve the power of flight, it needs to be able to obtain large supplies of oxygen to provide it with sufficient energy. This must penetrate all the tissues of the body, and reach every muscle. In the case of insects, the whole body is penetrated by a system of tubes, consisting of a pair of long tubes running the length of the body, called *tracheæ*, which give off branches to all parts. The tracheæ are connected with the surface by means of short lateral tubes, opening by pairs of *spiracles*, usually on each joint or segment. Generally, telescopic movements of the segments assist in pumping air into the tubes. The spiracles are closed and the air forced into the finer branches.

Insects belong to the group of invertebrates called *Arthropoda*, because they have jointed legs. The whole body and legs are encased in a horny skin of a substance called *chitin*, arranged in overlapping plates on the upper and under sides of the body and round the legs. The body is divided into, usually, thirteen segments, covered with these plates. These are generally partially fused together, so that three distinct regions are formed—the head, the thorax, and the abdomen.

The *head* is hard and smooth, provided with eyes, a pair of jointed feelers or *antennæ* also covered with chitin, and three pairs of jaws varying in pattern according to the method of feeding. Although these structures are called jaws, they are not inside but outside the mouth, and are more like tiny modified legs, but with biting or gripping edges, or transformed into sucking-tubes or pumps. They are arranged in pairs on either side

of the mouth and, if they remain separate, work sideways, using the rigid head as a fulcrum against which to work.

The thorax consists of three partially fused segments, and supports three pairs of legs and the wings. The armour of chitin, besides protecting the internal parts of the body, serves as an external skeleton (or *exoskeleton*) to which the muscles are attached and upon which they work. It will be seen that in all flying insects, and they are the majority, it is important that the wings shall work from a rigid base. This is provided by the fusion of the chitinous plates covering the thoracic segments. It will be noticed that this part of the body is usually the thickest in insects. This is because it consists largely of the strongly-developed flight-muscles (especially noticeable in the hawk-moths and dragon-flies, the latter being insects of prey in their habits in relation to other insects, and swift, strong fliers).

The abdomen is the remaining part of the body, usually with the segments free. It has no legs or other appendages, except, possibly, on the last segment leaf-like or thread-like outgrowths called styles.

Specialisation for flight is helped by the peculiar division of the life history of insects into three distinct phases, so that different activities can be carried on at different periods. In the butterflies and moths the egg hatches into a *larval* stage, the caterpillar, which devotes itself entirely to feeding. (Larva = a young stage which differs in structure from the parent; e.g., a tadpole, a "maggot" or "grub," a caterpillar.) From time to time it sheds its skin, and in the interval grows larger. The new skin then hardens.

When large reserves of food have been stored, the caterpillar passes into a resting-stage—or becomes a *pupa*—the *chrysalis*. Although quiescent, this is in reality a time of great internal change and strain, and there is a high mortality. The whole caterpillar body is reorganised. The pupa is covered by a horny skin, through which, if no cocoon or wrapping is formed, the wings and legs of the developing butterfly can usually be seen pressing upon it.

The pupal skin is cracked and the fully-developed butterfly or moth emerges. This is called the *imago*. It is free to fly, and its only duty towards the race is to lay eggs. Curiously, in many insects, this duty absorbs the imago life completely. The power of flight enables the insect to select a suitable spot for its eggs, and after laying them the majority die, though late broods of butterflies and moths; e.g., the small tortoise-shell butterfly, hibernate till the spring before egg-laying. In some of the gnat-like insects the imago is even unable to feed because it has no mouth.

The wide range of food chosen by insects, both in the imago and the

larval stages, gives them their economic importance. Many of them become plant pests, by stripping leaves, burrowing into wood, and causing deformities in growth. Others become animal pests, feeding upon their blood and in some cases conveying and injecting the germs of disease, such as sleeping sickness and malaria. The ichneumon-flies make a speciality of laying their eggs in the bodies of grubs; thus they may be incidentally useful to man in checking certain plant pests, such as the larch-fly and the cabbage white butterfly. The latter is particularly liable to be attacked by an ichneumon whose small yellow fluffy cocoons cover the surface of the caterpillar in the late autumn.

BUTTERFLIES AND MOTHS

The name used in zoological classification for the order of Insects comprising butterflies and moths is *Lepidoptera*—"scale-winged." They are distinguished from all other orders of insects by the scaly covering of the wings, body and appendages which comes off on the fingers as a dust when these insects are handled. Most *Lepidoptera* also possess a tongue, or *proboscis*, in front of the head.

Metamorphosis is complete and the larvæ are caterpillars which carry up to a maximum of eight pairs of feet, three pairs on the thorax corresponding to the three pairs of the imago. The pupæ generally have their appendages more or less glued down to the body and are frequently enclosed in a silken cocoon or in an earthen cell.

The head of a butterfly or a moth is small and sub-globular in shape. The large compound eyes are well developed and there is usually a pair of simple eyes or ocelli. The antennæ are many-jointed. In many moths they are thread-like, in others they bear comb-like processes which are most pronounced in the male. Among butterflies the antennæ terminate in a club or a knob, a feature which helps to distinguish them from moths. Butterflies normally rest with their wings folded together over the back, so that only the under surface of them is visible; moths, as a rule, rest with the wings flat and the upper surface exposed.

The sense of touch, which is seated in the antennæ, is acute, and is of great importance to a creature that seeks its food inside the corollas of flowers. It appears that the sense of smell is also seated in the antennæ. In some male moths smell is very keen for they can detect the female at a considerable distance. The knowledge of this fact is sometimes used by collectors. If, for instance, a freshly emerged female oak-egg moth is put in a box having a perforated lid and placed out of doors, a number of males will almost certainly assemble round the box in a short time.

The proboscis is usually formed of the two soft jaws which are long and grooved and held together to form a tube, which is used in sucking up nectar from flowers. In some Lepidoptera the mouth-parts are aborted and no food is taken in the adult stage. At the other extreme the proboscis of certain hawk-moths is six inches or more in length. When not in use the proboscis is coiled like a watch-spring against the lower surface of the head.

The Lepidoptera, like the bees, are the means of bringing about cross-fertilisation of many flowers. In pushing down to suck up the nectar, the head of the butterfly or moth is almost certain to brush off pollen from the anthers and to transfer some of this pollen to the stigma of the next flower that is visited.

The wings consist of an upper and a lower membrane, with a framework of hollow tubes, acting as ribs, between the layers. These tubes, usually called "veins" or *nervures*, run from the base of the wing (where it is attached to the thorax) to its outer margin. They branch very frequently so that there are many more nervures at the margin than at the base. The cross-nervures in the wings are few or are entirely absent. When present, the areas enclosed by the cross nervures are called "cells."

The wings are usually clothed with modified hairs termed scales. In many species almost every transition between flattened hairs and broad scales can be detected under a microscope. Each scale is provided with a minute *pedicel* which fits into a tiny socket in the wing membrane, and in many butterflies they are arranged in regular rows like tiles upon a roof. The colour of Lepidoptera is chiefly due to pigment contained in the scales or adhering to the interior of their upper side. When a butterfly emerges from its chrysalis, the wings hang like two little bags on each side of the thorax. As they expand the upper and lower surfaces come together, eventually closing so tightly that the two layers can be detected only by microscopic examination.

The vast majority of the Lepidoptera pass the winter in the chrysalis stage. Some of the grass-feeding species of caterpillars and also some of the stick-like loopers of the Geometric moths hibernate as caterpillars. The caterpillar of the silver-washed fritillary butterfly emerges from the egg in late summer, eats a little of the egg-shell and then on this meagre meal hibernates till the spring.

Some common butterflies which hibernate as imagos are the tortoise-shells, the peacock and the brimstone. These butterflies may often be found asleep during the winter in barns, outhouses, in thick ivy and other such places.

PLATE 45.* STAGES IN THE LIFE HISTORY OF BUTTERFLIES—A

The Peacock.—This handsome and well-known butterfly hibernates during the winter and can be seen on the wing again in March and April, but it is much more common in the early autumn. In August and September it frequents gardens where there are Michaelmas daisies and other tall-growing, flowering plants; it may often be seen on the fallen fruit of the orchard. The butterfly is distinguished by its particular badge of "peacock-eyes" on its warm, brownish-red, velvety wings. The "eyes" on the hind wings are markedly like those on the tail feathers of the peacock; their colour is blue and black in a narrow circle of creamy-yellow. The underside of the wings is in striking contrast to the upper side, having a general appearance of dark, brownish-black crossed by many irregular black lines. The outer margins of the wings are serrated.

The eggs are laid in April and May in batches on nettle-plants upon which the larvæ feed. The body of the full-grown larva is covered with short black hair which gives it a velvety look. It is dotted with white and has black, glossy spines.

The larvæ pupate under the lower leaves of the nettle-plant. The chrysalis varies a good deal in colour but pale greenish and pale brown are common.

The Painted Lady.—In some years this butterfly migrates in great numbers to our shores from the south of France and northern Africa. Probably the butterflies seen during the months of May and June are immigrants. Those which emerge in this country are seen in August, especially where thistles abound on waste ground.

The upper surface of the wings is of a tawny-yellow colour, mottled and speckled with black and having white spots near the tips of the forewings. The body and the base of the wings are of a light brown colour; the outer margins are slightly notched.

The under surface of the wings is a light greenish-brown, mottled whitish with a large patch of pink on the forewings spotted with black and white.



FIG. 33. Painted lady butterfly.

As shown on the Plate, eggs are laid singly on the leaves of thistles. The caterpillar is a dark greyish-green with an interrupted yellow stripe on each side. The spines are short. The caterpillar feeds inside a covering made by drawing together the edges of a leaf and fixing them with silk, but its presence is disclosed when it eats away the leaf.

- The chrysalis, which is suspended from a leaf-stalk, is of a pale brown colour with light spots and shining golden spots.

The Common Blue.—This butterfly, which is found almost everywhere in the country, may be seen throughout the summer from May to September. The colour of the male is blue suffused with violet; the female is brown, having a series of black and orange crescents on the margins of the forewings, and of black, orange and white crescents on the margins of the hind wings. The underside of the butterfly is delicately spotted grey and tawny. When at rest this colouring makes a remarkable camouflage.

The common blue is found especially on heaths and in open country particularly in chalk districts. It haunts bird's-foot trefoil and rest-harrow, where the eggs are laid on the upper surface of the leaves. The caterpillar is green, covered with short, brownish hairs; it is wrinkled on the sides and ridged on the back. It is rather slug-like in appearance.

The pupa is placed among the stems of the food-plant in a loosely woven cocoon formed of a few threads of silk.

The Red Admiral.—This handsome butterfly is common in all parts of the British Isles. It is mostly seen in August and September feeding on hemp agrimony, garden sedums and Michaelmas daisies; it is fond of over-ripe plums and pears.

The red admiral is a close relation of the peacock butterfly, but instead of "eyes" it has scarlet bars on a black ground, dotted on the forewings with white, and with small dots of black on the scarlet parts of the hind wings. The margins of the wings are scalloped in white. On the underside, the colouring of the forewings is much the same as that on the upper surface, except that the tips are coloured like the hind wings. These are mottled with light shades of brown crossed by black, wavy lines. There is a large square-shaped, yellowish-white spot on the front edge of each hind wing.

The eggs are laid singly on the leaves of the nettle-plant. The blackish caterpillar has a broken yellow stripe on each side and rows of branched spines. The caterpillars feed singly, each making for itself a cover by spinning together the leaves of its food-plant.

The greyish-brown pupa, which is suspended from the underside of a leaf, has a golden sheen.

The Small Tortoiseshell.—This is one of the commonest butterflies as well as one of the prettiest. There are two broods in the year, one in June, the other in August or September. Some of the late brood hibernate and reappear in early spring.

The colour of the upper surface of the wings is a deep reddish-orange and brown with squarish spots of yellow and very dark brown. The slightly notched outer margins are bordered with light brown and blue crescents. The underside of the wings is in sombre shades of greenish-yellow and blackish-brown.

As illustrated on the Plate, the female lays a cluster of eggs on the under surface of a nettle-leaf. The full-grown caterpillar is of a dull, yellowish-green colour closely covered with short black hairs. There is a black line down the middle of the back and a broken, greenish-yellow stripe on each side. The yellowish spines have black tips.

The colour of the chrysalis, which is suspended from a stalk, is a greyish-brown with darker markings.

The small tortoiseshell, the peacock, the painted lady and the red admiral (all illustrated on Plate 45) belong to the sub-order *Nymphalinae*, a widely distributed family of butterflies, distinguished by having the forelegs much reduced in both sexes, so that they are useless in walking and are carried folded on the breast. Owing to this they are called *four-footed butterflies*. The larvæ are usually spiny, and the pupæ are generally angular in outline and hang suspended by the tip of the tail.

The Meadow Brown.—This is probably our commonest butterfly and, as its name implies, is of various shades of brown and is found chiefly in meadows where the caterpillar feeds on grasses. It flies slowly and, unlike most butterflies, is on the wing in dull or even showery weather, as well as in sunshine. It can be seen from June to September, not only in meadows, but also in open places in woods, in highways and byways, and in gardens.

The meadow brown is of a dusky-brown colour marked, especially in the female, with a dull orange patch on the forewings in which is a small black ring. The underside of the wings is of varying shades of brown.

The female deposits her eggs on the blades of grass upon which the caterpillars feed. The colour of the caterpillar is bright green with darker dorsal stripes and cream-coloured lateral ones.

The chrysalis, which is suspended from a grass stem, is of a pale green colour marked and spotted with brownish-black.

PLATE 46. STAGES IN THE LIFE HISTORY OF BUTTERFLIES—B

The Orange Tip.—This butterfly emerges in early summer and may be seen in damp meadow-land towards the end of May and in June. The male gives the name to this butterfly, for it has on its creamy-white wings a large patch of orange near the tips of its forewings. The extreme tip of the forewings is blackish. The female has no such orange markings but the blackish patches at the tips are more extensive than those of the male. The under surface of the wings is of a delicate mottled green colour which affords excellent protection to the butterfly as it rests on a plant. The green tints show through the lower wings giving them a dappled, greyish-green appearance. On the upper surface of each forewing of both the male and female is a small discal black spot.

The butterflies illustrated in the Plate are shown resting on garlic mustard, but eggs are also laid on the foot-stalks of the flower-heads of other plants, notably hedge mustard and cuckoo-flower.

The colour of the slightly downy caterpillar, which feeds on the seed-pods, is bluish-green with black, raised dots; along each side is a whitish stripe. The colour and shape of the caterpillar make it difficult to see.

The chrysalis, also, is not easily detected, for it is much the colour and shape of a ripened seed-pod. It is suspended round the middle by a silken thread. The ends taper sharply, the back is curved and the wing-cases bulge out into an acute angle.

The Clouded Yellow.—This butterfly is most frequently seen in August and September in the eastern and southern counties, particularly in fields of clover and lucerne. It is easily recognised by its orange-coloured wings with deep, black borders. There is a deeper orange spot near the middle of each hind wing and a black spot on each forewing.

Eggs may be laid singly or in batches on the upper surface of clover and lucerne leaves. The caterpillar is of a smooth green colour, somewhat bluish below and with a yellow stripe on each side.

The chrysalis is well camouflaged by being leaf-like both in colour and shape. As it hangs suspended by a silken thread to a stem it greatly resembles a folded leaf. This is well shown in the illustration on the Plate.

The Wall.—This butterfly, as its name suggests, is fond of basking in the sunshine on walls, but it is as frequently seen on dry hedge banks, tree-trunks and other places exposed to the sun. There are usually two broods of the wall, or wall brown as it is often called—the first in May or

June and the second in July or August. Some butterflies of the last brood hibernate during the winter.

The colour of the forewings is a bright tawny-brown, boldly patterned with darker brown and each having a white-pupilled dark spot. The hind wings have two curved bars of tawny-brown and four dark spots of which three are pupilled. The forewings of the underside are lighter in colour but have similar markings to those of the upper side. The underside of the hind wings is of a grey colour transversely crossed by dark, wavy lines. On each hind wing there are six eyed spots.

The eggs are laid on grasses. The caterpillar is inconspicuous among the leaves as it is of a similar colour to them. It is lightly dotted with white and has a narrow, dark, longitudinal stripe on each side.

The chrysalis, which is suspended from a stalk, is much the same colour as the caterpillar—greenish-yellow with white markings.

The Silver-washed Fritillary.—This fine butterfly is not really common but it is found from June to August in the neighbourhood of woodlands, particularly in the southern counties. The colour of the wings is a tawny-orange patterned with black veins, spots and streaks. There is a delicate, black scallop pattern along the outer margins. This chequered, dice-box pattern gives the butterfly its name *fritillary*, from the Latin *fritillus*—dice-box. The under surface of the forewings is coloured and patterned much like the upper surface, but with some greenish spots along the outer margins. The under surface of the hind wings is streaked and spotted with metallic green on a silver-washed ground.

Eggs are laid on various plants and may be found, among others, on the dog-violet, raspberry, nettle and guelder rose. The rich, brown-coloured caterpillar, which conceals itself by day, has long stiff bristles, the two on the second ring being inclined forward over the head. It has two yellow lines along the back. As mentioned on page 200 the caterpillar, which hatches out in August, goes into hibernation after its first moult.

The chrysalis may be found suspended from a twig, or from some object near to the feeding-place of the caterpillar. It is of a brownish colour with dark spots and stripes and has a golden lustre.

The Brimstone.—This butterfly, like the tortoiseshells, has a long life. It emerges from the chrysalis at the end of July, hibernates during the winter and may be seen on sunny days in early spring, even in February. In autumn these butterflies are common and are often seen in numbers flying near the outskirts of woods.

The colour of the male is a bright brimstone above, with an orange spot in the centre of each wing, the tips of which are sharply pointed.

The colour of both sexes is similar, but that of the male is lighter than the female. The butterfly is of a beautiful shape when at rest. All the under surface of the wings is of a creamy-white colour suffused with yellow; the green veins are prominent. The antennæ of both sexes are reddish and the thorax is downy. It is probable that the name *butterfly* was first applied to this "butter-coloured fly."

The eggs are laid in May or June on the leaves of buckthorn. The caterpillar is of a smooth, bluish-green colour, with a light longitudinal line below on each side.

The chrysalis, which is suspended round the middle from a stem, is well concealed, for it has much the shape and colouring of a folded leaf of the buckthorn. This is clearly seen in the illustration on the Plate.

The Ringlet.—This butterfly is seen in July and August on commons and near the outskirts of woods, especially in the neighbourhood of brambles where it feeds on the nectar of the blossoms.

The wings are chocolate-coloured with three black spots having pale rings on the forewings, and two similar spots on the hind wings. Some of the spots have white pupils. The underside of the wings is a little lighter in colour and the spots are more prominent—three on the forewings and five on the hind wings. The outer margins of the wings are slightly scalloped in creamy-white.

The eggs are not attached to a plant but are let fall among the roots of grasses growing in damp places in woodland districts. The caterpillar, which emerges in August, is of an inconspicuous greyish-brown colour with a darker stripe along the back and a pale one with darker edges along each side. The caterpillar hibernates during the winter and then feeds on reeds and grasses until May or early June.

As shown in the illustration on the Plate, the chrysalis lies among the grass. It is of a brownish-grey colour with darker markings of brown.

PLATE 47. STAGES IN THE LIFE HISTORY OF MOTHS—A

• **The Cinnabar.**—The ancient meaning of cinnabar was *dragon's blood*, and the name given to this moth has reference to the vermilion colour of the hind wings and the spots and streak on the dark grey forewings. The moth flies mostly in the evenings at the end of May and in June. It is found particularly on waste ground where the ragwort flourishes.

The eggs are laid on ragwort upon which the caterpillars feed during July and August. The caterpillars are very striking in their colouring—alternate bands of orange and black. These bright *warning* colours,

somewhat similar to those of the wasp, afford the caterpillars protection from birds.

The chrysalis is found under the surface of the ground enclosed in a slight cocoon ; it is of a reddish-brown colour.

The Death's-head Hawk-moth.—This is the largest species of moth found in the British Isles. Its name has reference to the pattern resembling a skull on the thorax. It is a stout-bodied insect, the abdomen being boldly coloured in bands of yellow and black. The head, part of the thorax and a long stripe down the abdomen are of a violet-blue colour. The hind wings have the same colouring as most of the abdomen—yellow bordered with black ; the forewings are mottled in black and brown on a purplish ground.

This moth is the only British species which, when handled, emits a shrill squeak. The sound is produced by air from the air-sacs being forced through the proboscis. The proboscis is short and not adapted for obtaining nectar from long-tubed flowers. The moth robs the beehives of honey and its squeak is said to have the effect of quieting the bees.

The eggs are usually laid on the leaves of potato plants upon which the caterpillars feed. The full-grown caterpillar is nearly five inches long and of considerable thickness. The general colour is similar to that of the potato leaves—yellowish-green. There are on the back seven oblique side-stripes of a deeper colour dotted and edged with violet. There is a doubled curved horn at the end.

When ready to pupate, the caterpillar burrows below the surface of the ground and there forms an earthen chamber in which the purple-brown, glossy pupa rests.

The Broad-bordered Five-spotted Burnet.—This is a small moth which is seen in damp meadows during May and June. It has dark, bluish-green forewings each having five scarlet spots. Often, the spots are confluent, then apparently making three spots. The smaller, scarlet hind wings are edged with bluish-green and the general colour of the body is the same.

Eggs are laid in batches on the leaves of trefoil, vetch and other low-growing plants. The green caterpillar has a markedly notched back bordered with black and edged with hairs. It makes a straw-coloured cocoon attached to a grass stem where the pupa rests.

The Large Yellow Underwing.—This common and abundant moth is found mostly in June and July. It is frequently found hiding by day in the corners and crevices of garden out-houses and under tufts of grass. The slightly mottled forewings are coloured in various shades of brown and purple. The under wings, as the name of the moth implies, are

yellow. They have wide, black marginal bands. The body of the moth is a lighter shade of the same colour as the forewings.

The illustration on the Plate shows how great numbers of eggs are laid on the leaves of grasses; they are also commonly found on many garden plants where the caterpillars may often be a pest. The general colour of the caterpillar is greyish-brown with black markings on most of the rings.

The shiny brown pupa is often turned out when the garden is being dug up in the autumn.

The Emperor.—The male of this handsome, large moth is out on sunny days in April and May flying swiftly over the moors where heather abounds. The female flies at night.

The illustration on the Plate shows a female with closed wings. The distinguishing mark of both sexes is the "eye" on each of the four wings. The general colour of the female is pale purple; the outer margins are bordered whitish; there are pretty scalloped patterns of whitish and purple across the wings, and the "eyes" are placed in whitish patches. The short antennæ are conspicuously plumed.

The illustration on the Plate shows clearly how the eggs are laid in a band round a stem or twig of the bramble, sloe or other plant; frequently they are laid on the stems of heather. The full-grown caterpillar is of a bright green colour with orange warts from which arise blackish bristles. When ready to pupate in July or August, it forms a gourd-shaped cocoon so constructed at the narrow end that enemies cannot enter it, yet the moth can easily escape from it. When the moth has emerged the opening closes and it is difficult to tell from its appearance whether the cocoon is empty or not.

The Oak Eggar.—This large, thick-bodied moth may be found during July and August on commons and other open places. The illustration on the Plate shows a female with closed wings. They are about equally divided into two shades of tawny-brown, darker near the body and lighter towards the outer margins. There is a dark ring with a light pupil on each forewing. The male oak eggar is smaller than the female and much darker in colour.

The eggs are dropped as the female flies and they fall on the ground or on herbage. The full-grown caterpillar is of a dark, tawny colour similar to that of the male moth; the body is covered with brownish hair; the ring divisions are velvety black; white dots mark the spiracles. The caterpillars feed on bramble, hawthorn, dogwood, heather and other low-growing plants.

When disturbed a caterpillar falls from its food-plant and rolls itself

into a ring. The caterpillars hatch from the eggs in August and usually hibernate when quite small, feeding and growing up during the following spring and early summer.

The purplish-brown pupa is enclosed in a hard, oval-shaped, egg-like cocoon which is spun near the ground among dead leaves, etc. Probably the egg-shape of the cocoon suggested the popular name of the oak eggar moth.

PLATE 48. STAGES IN THE LIFE HISTORY OF MOTHS—B

The Drinker.—This common moth, which emerges in July, is so named from the habit of its larva of drinking or sucking up moisture—dew or rain—from the herbage on which it feeds.

The colours of both the male and the female vary a good deal; the male illustrated in the Plate may be described as of a tawny-yellow; the veins are of a darker colour and the wings are crossed by still darker lines. There are two lighter coloured spots on the forewings. The body, which is thick and downy, is of the same general colour as the wings. It will be seen from the illustration that the moth at rest with tightly-closed wings is inconspicuous among the grasses.

The illustration shows how the eggs are laid in clusters on the stems of grasses. The hairy caterpillar is dark grey; the lines on the back are made up of yellow dots and dashes; on the sides are shaggy tufts of white hairs. Two pencils or tufts of hairs project from the back, one near the front and the other near the hind end of the body. The caterpillar feeds on coarse grasses from August to October when it hibernates. It resumes feeding in April and pupates in June.

The chrysalis is fixed to a grass stem in a light brown cocoon which is sharply pointed at the lower end.

The Magpie.—Both the moth and larva of this common species are *pied*. The foundation colour of the moth's wings is creamy-white with black spots and streaks very variable in number and in depth of colour. There is an orange band on each of the forewings as well as at their base, and the body is of the same colour spotted with black.

The caterpillar has black spots on a cream ground and an orange longitudinal stripe above the legs on each side.

The moth is often known as the currant or gooseberry moth, for the caterpillars do much damage to these fruit bushes. They are also very common on the evergreen *Euonymus japonicus*. The caterpillar has only one pair of pro-legs besides the claspers. When moving forward, it first

waves its head and thorax in the air, then carefully places its walking-feet on a stem. It next contracts its body into an arch, at the same time bringing its pro-legs forward. It then holds by the claspers and straightens its body again. From this habit of walking the caterpillars are known as "loopers." Sometimes they are called "geometers" (earth-measurers) because of their way of appearing to measure each step.

If a branch on which a caterpillar is feeding is shaken, it will at once emit a thread of silk from its spinneret and, holding on to it with its jaws, allow itself to drop. It will then either climb up the thread again, using its thoracic legs and apparently eating the silk, or it will swing to a new support.

When ready to pupate, the caterpillar spins a loose net of silk in the axil of a leaf, splits its skin for the last time and appears as a small, golden-yellow pupa which in a few hours becomes banded with black.

The "warning" colours of the magpie moth, its caterpillar and pupa, afford protection from birds. Fowls have been known to refuse to eat the caterpillars.

The Brimstone.—This is a delicate-looking moth which might at first sight be mistaken for a butterfly. It is quite common and may usually be found in May and June. The body and wings are of a bright brimstone colour; there are brown markings on the front margins of the forewings.

The eggs are laid in clusters on the upper sides of leaves, especially those of the blackthorn and hawthorn. The caterpillar at rest looks much like a dead twig. It varies a good deal in colour from greyish-green to greenish-blue. Two specimens are illustrated on the Plate. The caterpillar loops as it crawls and there is a conspicuous forked hump on the sixth ring. It hibernates during the winter; a second generation occurs in the summer.

The pupa is enclosed in a whitish-brown cocoon.

The Privet Hawk.—This large handsome moth is so named from the food of the larva. The moth appears in June or July. The long, pointed forewings are mottled and marbled with white and dark brown stripes and streaks on a greyish-fawn ground. The hind wings are pink crossed with wide, dark brown bars. The head, thorax and part of the abdomen are coloured like the forewings; the remainder of the abdomen has pink and brown bars the colour of the hind wings.

The eggs are laid singly on the upper surface of privet leaves. The full-grown caterpillar is three inches or more in length. Its green colour harmonises with its surroundings; there are on each side seven oblique white stripes each with a purple edging; the spiracles are yellow; the

curved horn is blackish above and yellowish below. During the months of July and August the caterpillar feeds voraciously on the leaves of privet. Before pupating it burrows some depth underground. The chrysalis is of a shining, reddish-brown colour.

The family of hawk-moths is well represented in Britain. They have very thick, torpedo-shaped bodies, long narrow wings and thick antennæ pointed at the tips. The caterpillars are usually smooth-skinned and are provided with a projecting horn on the eighth segment of the abdomen. In most of them, the sides are marked with seven oblique coloured stripes. The caterpillars pupate in the ground where they remain during the winter.

The Scarlet Tiger.—This is a common but very striking moth which emerges in June and may often be seen in the garden. The forewings are boldly patterned in a sort of dark brown and white trellis-work; the hind wings are scarlet with deep bluish-black patches. The head and thorax are coloured like the forewings, and the abdomen like the hind wings.

The yellow eggs are laid in clusters on the leaves of groundsel, plantain and other low-growing plants. The caterpillar is the well-known "woolly bear" often to be seen walking rapidly with a rippling movement along the grassy roadsides. It has a dark body covered with long brown and black hairs; there are bands of yellow spots along the sides. The hairs can be shot out if the caterpillar is alarmed, and they may cause considerable irritation to the skin.

The caterpillars hatch out in July and August, feed for a time and then hibernate, completing their growth in the spring.

The dark red pupa, almost black above, is enclosed in a felt-like cocoon which is spun among leaves on the ground and is made of silk mixed with hair cut off with the caterpillar's jaws.

The Lappet.—This moth is so named from the lobes or lappets at the sides of the body of the caterpillar. The moth emerges in June or July and flies at night. The general colour of the wings and large body is a warm, purplish-brown, not unlike the colour of young copper-beech leaves. The forewings are crossed with three darker lines and the hind wings with two; the veins are prominent. The wings are rounded and their lower margins are smoothly scalloped.

The illustration on the Plate shows how the eggs are laid in small clusters on twigs and stems of food-plants for the caterpillars—sloe, hawthorn, apple, etc.

The large, full-grown caterpillar is of a dark grey colour clothed with fine, short, blackish hair. The fleshy lappets are covered with a fringe of

brownish hair. The divisions between the front rings are deep blue. There is a hairy prominence on the segment next to the last. The caterpillar feeds for a few weeks and then hibernates on a stem of its food-plant.

The illustration on the Plate shows the long, grey-brown cocoon of silk and shed hair attached to a stem.

PLATE 49. STAGES IN THE LIFE HISTORY OF MOTHS—C

The Goat-moth.—This moth is so named from the goat-like smell emitted by liquid which the larva excretes. The general colour of the body and wings of the moth is greyish-brown mottled with lighter tints ; the thick body is banded by light bars.

The illustration on the Plate shows how the eggs are laid on the bark of a tree—willow, elm, poplar, etc. The caterpillar on emerging burrows into the tree and eats the wood. The full-grown caterpillar is of a general fleshy-red colour above and yellowish below. The head and first segment are black. As the caterpillar remains in the larval state for from three to four years, it can do much damage to a tree.

The light chocolate-brown pupa is enclosed in a cocoon generally placed near a decaying log and roughly made of fragments of wood gummed together and lined with silk.

Lime Hawk-moth.—This handsome moth is so named from the food-plant, the leaves of the lime, upon which the larva feeds. It also feeds on the leaves of the elm tree. The moth emerges in May and June and may be found at rest on the trunks of trees.

Like other hawk-moths, this one has long, narrow, pointed forewings, with much smaller hind wings ; the large torpedo-shaped body ends in a point.

The forewings of the lime hawk-moth are olive-green with pale or whitish tips and with two broad bands of mauve-pink, one close to the body and the other nearer the edge. There is a deep " V " indenting each inner margin. The hind wings are pinkish with a brownish band across each.

The eggs are laid singly or in pairs on the underside of leaves. The caterpillar is bright green with light orange spiracles and oblique, lateral bands of yellow and red. A prominent curved spine or horn projects from the end of the body.

The dark chocolate-coloured pupa is enclosed in a thin earthen cell made by the caterpillar a few inches below the ground.

The Buff-tip.—This is a common moth easily recognised by the thumb-like marks of a buff colour on the tips of the forewings. The rest of the forewings are silvery-grey with dark brown wavy streaks. The hind wings are cream-coloured, slightly shaded with buff. The downy body of the moth is of the same general colour as the forewings. The moth usually flies by night in June and July. The illustration on the Plate of a moth at rest with tightly-closed wings, shows how well it is protected by its colouring.

The female lays her whitish eggs in clusters mostly under the leaves of oak, elm and lime trees. The downy yellow caterpillar is marked longitudinally with broken blackish lines. It feeds during August and September and when, as is usually the case, there are a number feeding together, they quickly strip the branches of leaves.

The pupa is of a purplish-brown colour.

The Red Underwing.—As its name implies, the under wings of this moth are of a bright red (crimson) colour. There is on each a broad black border and a narrow, curved, black inner band. The forewings are grey with wavy dark lines. The body is of the same general colour as the forewings.

It will be seen from the illustration on the Plate how well the colouring of the forewings harmonises with the colour of the bark upon which the moth is at rest.

The purplish-coloured eggs are laid on the bark of poplar and willow trees. The caterpillar, which emerges in April, is not easy to find as it is of similar colouring to the forewings of the moth—grey, mottled with brown. It feeds at night and lies hidden in the crevices of the bark during the day.

The brown chrysalis is not shiny as are so many, for it is thickly powdered with bluish-white. It is enclosed in a strong cocoon spun among the leaves of the food-plant of the caterpillar. The moth emerges in August and September.

The Puss-moth.—The whole body of this moth—head, thorax and abdomen—is very furry. The body and wings are pale grey mottled with darker spots and streaks. The moth is common in the neighbourhood of poplar trees, of sallows and willows. It is on the wing in May and June.

The purplish-coloured eggs are laid in pairs on the upper surface of a leaf. The full-grown caterpillar has a unique appearance when alarmed, its characteristic attitude being shown in the illustration on the Plate. The large thorax broadens to a peak on the dorsal side and the abdomen narrows to a point. From the claspers, which are modified into long

tubes, two fine pink streamers are quickly protruded and vigorously waved. The underparts of the caterpillar are bright green. A broad purplish band edged with white spreads over the back and extends laterally into a "saddle." The bright red "face" is really the head drawn back into the first thoracic ring. The curious form of the caterpillar, its "face," its waving streamers and vivid colouring give it a terrorising appearance which is probably a protection against enemies. It is a perfectly harmless creature.

The illustration shows how well the cocoon fixed to the bark of a tree is protected by its colouring. Bits of bark and wood are used in its construction and stuck together with fluid produced by the caterpillar. The exit for the moth is made thinner than the rest of the cocoon, and the pupa is provided with a keel-like arrangement on the forepart with which it breaks down the thin end of the cocoon at the right time. The moth breaks the end of the pupa case and moistens the ruptured end of the cocoon with a softening fluid, so enabling it to make its way out.

The Poplar Hawk-moth.—This is the commonest of the British hawk-moths. It is found in May and June in the neighbourhood of poplar trees, upon the leaves of which the larvæ feed. They are also found on willows and salallows. The illustration on the Plate shows how well the colouring of the moth at rest on a branch harmonises with its surroundings.

The general colouring of the body and wings is light brown with a broad band of deeper brown and other lighter bands across the forewings. In each of the broad bands there is a white spot. The hind wings are more uniformly coloured but each has a deep, reddish-brown patch at the base.

The illustration shows that the glossy green eggs are laid singly or in twos and threes on a leaf. The full-grown caterpillar is yellowish-green; the back is darker and is crossed by seven yellow stripes; the spiracles are reddish and the horn is tipped with red.

The dark brown pupa lies just under the surface of the ground. There is no cocoon.

OTHER INSECTS

PLATE 50. STAGES IN THE LIFE HISTORY OF BEETLES

Introduction.—Beetles belong to the order of Insects known as *Coleoptera*—"sheath-winged." They have three parts to their bodies—head, thorax and abdomen—but the parts are not so distinctly separated

as in those of butterflies. They have three pairs of jointed legs and, usually, two pairs of wings.

The bodies of beetles are entirely covered with horny skin; the forewings are also horny and they form sheaths to protect the delicate, transparent flight-wings, which are closely folded under the sheaths when not in use. The wing-covers, when closed, usually meet in a straight line down the middle of the insect's back.

Beetles undergo a complete metamorphosis. The larva is usually a pale-coloured grub, some with soft, others with chitinous skin. Many soft grubs are legless; others have three pairs of thoracic legs, but there are no pro-legs, as is the case with caterpillars. The pupa is soft and is not enclosed in a protective shell.

The mouth parts of beetles are modified for biting and many of them feed upon the same or similar kinds of food as the grubs.

The Cockchafer.—During the months of May and June these rather clumsy beetles may be seen, and heard, flying heavily in large numbers at dusk. They are often called "May-bugs." An adult cockchafer is about 1 in. long, with the head and thorax black, and the wing-cases (*elytra*) reddish-brown, hairy, and with five raised parallel lines on each. The sides of the body are marked with wedge-shaped, white patches and the antennæ bear fans at their tips, those of the male being much larger than those of the female.

The creamy-white eggs are laid in batches of 12–30 in the soil at a depth of about six inches. After about six weeks, the larvæ hatch, feed for a time on decaying vegetable matter and then on the roots of plants. Feeding continues until the third or fourth year, depending on climatic and food factors. The larva is a dirty-white, fleshy-looking grub with a curved body, hard brown head and strong jaws. The end of the body is swollen and of a dark, purplish-brown colour. There are three pairs of jointed legs on the thoracic segments, which are placed behind the head. The larva always lies in a curved position like a letter "C."

The pupa is white and soft and lies in an earthen cell deep in the ground. In a short time the perfect insect throws off its pupal skin, but remains underground until the following May.

Not only do the grubs do much harm by eating the roots of growing crops, but the cockchafers also eat vegetable food. They feed on the leaves of trees, especially oaks and shrubs, and, sometimes, when very numerous, strip them of their leaves. The adults live for only three or four weeks.

The Turnip Flea Beetle.—These are very small beetles, not more than $\frac{1}{8}$ in. long, which eat the seed-leaves (cotyledons) of members of the

Cabbage and Turnip Family (*Cruciferae*). Some are metallic blue and black, others have a yellow stripe on the black wing-cases. It is the adult beetles that do the damage to growing crops. They are so called from their habit of jumping like fleas when disturbed. They spend the winter in haystacks near turnip fields, among leaves in hedge bottoms, in heaps of rubbish, etc., and emerge when the first seedlings are barely out of the seed. At first they feed on any *Cruciferae*; later, they usually concentrate on turnips, swedes and cabbages, flying from crop to crop.

Eggs are laid on the soil from the end of May to September; young larvæ either crawl up and burrow into leaves, or down into roots (different species behaving differently) where they live until they are ready to pupate, when they crawl into the soil. The beetles emerge about mid-summer and live on through the winter until the late summer of the following year. The irregular holes all over the seed-leaves and first foliage leaves of seedlings betray their presence.

The Devil's Coach Horse.—This is one of the carnivorous beetles which does much good service in garden and field by feeding upon all sorts of grubs. It is one of the "Rove Beetles," so called from its roving habits. When alarmed it curls its "tail" upwards and backwards, and from this habit it is often called the cocktail beetle.

It is a rather sinister-looking beetle, long and narrow, sooty-black in colour with very short elytra under which the transparent wings are closely packed. It has powerful jaws and long antennæ.

In addition to the threatening attitude displayed by cocking its "tail," it protects itself by squirting an unpleasant-smelling fluid from two small bladders at the end of its abdomen.

The larva has much the general appearance of the adult beetle but is brown, not black, and, of course, has no wings. It feeds chiefly on burrowing-insects and small worms. The pupa lies in a little cell dug out by the larva, and emerges as a beetle in two or three weeks.

The Click Beetle.—This dark-brown beetle, which is about $\frac{1}{2}$ in. long, may often be seen on the flower-heads of plants during May and June. The beetle is so called from its habit, after falling on its back, of springing into the air with a *click* and so righting itself. The first segment on the underside of the thorax is elongated into a central spine which points backwards and fits into a groove in the second segment. If the beetle is put on its back it moves the forepart of the body (head and prothorax) away from the hind part, so that it rests on the thorax and the tip of the abdomen and the spine rests on a ridge above the groove. Suddenly the beetle contracts its muscles so that the spine is forced past this ridge into the groove with a "click." This sudden movement causes the body

to bend in the opposite direction with such force that it is jerked into the air reversing its position, and the beetle alights on its feet. The click-beetle is also known as the *skipjack*.

The milky white eggs are laid in June and July either singly or in clusters at the base of plants or beneath the surface of the soil. The young larvæ emerge in about a month and feed at first on decaying vegetable matter. Full-grown grubs have slender, worm-like, polished bodies of a brown or yellowish-brown colour. There are three pairs of short legs situated on the first three segments immediately behind the head, and a process on the last segment which serves as an extra foot. The larvæ look somewhat like bits of rusty wire and are commonly known as *wireworms*.

Wireworms are most destructive to crops. From three to five years they burrow about in the soil feeding on roots, bulbs, potatoes, carrots and other such crops. The full-grown wireworm hollows out a small cell in the soil and then pupates. The adult click beetles live for a short time among the leaves and flowers of plants, but they do little damage to them.

The Stag Beetle.—This is the largest beetle found in Britain. It takes its name from the enormous jaws of the male which resemble the antlers of a stag. The colour of the beetle is dark, reddish-brown. It is a formidable-looking insect but its mandibles are used only in fighting-contests to gain a mate. Its food is the sweet juice which exudes from oak trees. The larva is much like that of the cockchafer, but larger. It burrows into and feeds upon decaying logs and tree stumps, continuing to grow for four years. It then forms a cell in the rotting wood and pupates. During the winter, the pupa becomes a beetle which, however, remains in the decaying wood until the following June.

The Tiger Beetle.—This bright green beetle with white spots on the elytra is found running and flying actively in dry places in the first days of summer. The body is rectangular in shape, long and broad; the legs are long and slender. It has powerful mandibles and long, thread-like antennæ which are inserted above the base of the mandibles. It is a voracious feeder on insects.

The whitish, soft-skinned larva has prominent and powerful mandibles also, for it, too, devours insects. If the edge of a path on a common or any bare patch is explored in August, there will be found small circular holes with smoothly-rounded edges. Near the entrance of a hole may be seen the brown head and conspicuous eyes of a larva. If an insect happens to wander near one, it is at once seized and carried to the bottom of the burrow to be eaten at leisure. The burrow is dug out by the larva, which has two curved, hook-like spines on a prominence on a middle segment at the back

of the abdomen. The spines are used for anchoring the larva at the top of the burrow, when waiting for its prey. The broad, hard head of the larva is said to be used like a bricklayer's hod for carrying earth up from the burrow and throwing it out.

When fully fed, the larva makes a sloping cavity at the bottom of the burrow, filling it up with excavated earth. It then turns into a pupa, which is supported by a spine on its back. The adult beetle shortly afterwards emerges and remains underground until the spring, working its way out, on a bright, warm day.

PLATE 51. STAGES IN THE LIFE HISTORY OF BEES AND WASPS

The Honey Bee.—Bees are insects belonging to the order *Hymenoptera*—"skin-winged," which comprises insects possessing four transparent wings. The wings are held together in pairs by minute hooks so that in flying each pair functions as one wing.

Bees are also distinguished by belonging to the sub-order *Aculeata*—"having a sting." The ovipositor of the female is modified to form a sting. The males have no sting.

Honey bees live socially in large colonies. There are three castes of individuals all of which are winged—queens, males and workers. The queen may be recognised by the long abdomen. Her life is devoted to laying eggs and she may, during a summer, lay from two to three thousand eggs a day. She is provided with a sting which she will use only against another queen.

The workers are females having the sexual organs imperfectly developed. They undertake all the duties of the colony, gathering nectar and pollen, making waxen cells, feeding the larvæ, nursing the young, etc. Parts of their bodies are specially adapted for their mode of life. The long tongue is furnished at the free tip with a spoon-shaped structure provided with hairs and used for collecting nectar. The hairs get soaked in the fluid which is then sucked up by the surrounding tube into the mouth. A secretion from the salivary glands transforms the nectar, which is swallowed, into honey which can, when needed, be regurgitated. The mandibles of the bee are used chiefly in forming the honeycomb.

Each leg of a bee ends in two long and two short claws with a pad between. The claws enable the bee to climb and to cling to rough surfaces; the pad secretes a sticky substance which enables the bee to climb smooth surfaces. On each pair of front legs is a "comb" consisting of a slight depression covered with hairs and used for cleaning the antennæ. On

each pair of middle legs is a prong used for preening the wings and for digging out pollen from the "pollen-basket." The pollen-basket is a special structure on the last pair of legs. The hard shins of these legs are somewhat broadened and flattened, and hollowed out on their inner sides, where they are also provided with rows of stiff bristles. As the bees travel from flower to flower, the hairs on their bodies become covered with pollen. This the bees brush off with their hairy legs into the "pollen-baskets."

The sting of a bee is barbed at the tip, so that when a bee stings and presses home its lancets fully, it cannot withdraw them without separating the sting from the body. The insect then dies.

The males or drones are broader and thicker bodied than the workers. They have no honey-baskets and their only share in the work of the hive is to impregnate the queen.

A swarm of bees that is about to make a new home consists of the old queen and some thousands of workers. Some of the workers collect from the buds of poplars and other trees a sticky substance called *propolis*; this they work up into a ball which they carry to the hive in their pollen-baskets. With this propolis they fill up any cracks in the walls. Other young workers secrete scales of wax from glands on the under surface of the body. By means of a tiny pair of nippers formed by a joint below the tibia of the back legs, they pick off the wax scales, transfer them to the mandibles, or jaws, where the wax is worked up with saliva, and finally attach the sticky threads to the roof of the hive.

Soon a mass of wax is produced hanging from the roof. Older bees hollow and shape the wax into hexagonal tubes. In each tube, or cell, the queen deposits an egg, fixing it to the bottom with a sticky secretion. Workers cluster over the cells and so keep them warm. In about three days hatch out legless grubs which young workers "nurse," feeding them first on pap secreted in their mouths, and then on a paste of "bee-bread" made of honey and pollen.

The grubs grow rapidly and moult several times. In about five days, when they are full-grown, the nurses cap the cells with a porous lid of wax, and the imprisoned grubs partly cover themselves with silk threads and pupate. In about one week the imago is ready to emerge. It bites its way through the silk and round the cap of the cell until the cap swings back and the bee is able to emerge. The nurses then clean and brush her and feed her with honey, and in a few hours she is able to take her share in the work of the hive.

The business of some workers is to attend to the queen whom they keep well fed; a large number collect nectar and store the regurgitated

honey in special cells ; others are occupied in ventilating the hive by the vibration of their wings ; some do the cleaning, carrying outside any dirt that may accumulate, and still others act as sentinels to guard the hive against intruders.

On the approach of cold weather the ceaseless activity of summer gradually slackens. The queen no longer lays eggs. The drones and the remaining grubs are killed by the workers and their bodies cast out of the hive. The remaining workers cluster round the queen on the top of the cells keeping as close together as possible for warmth. Since the middle is the warmest place, the bees change places constantly, so that those which have become cold have a chance of getting warm again. Those bees near the honey cells lick up the honey and pass it on from one to another.

The Common Wasp.—This well-known insect with its “ warning colours ” of black and yellow bars is distinguished from other *Hymenoptera* by the manner in which the first pair of wings folds down longitudinally when the insect is at rest. The wings then look only half of their natural width.

The face and powerful jaws are directed downwards. On the top of the head are three simple eyes set as a triangle with the point forwards. The large compound eyes are kidney-shaped. The long, black antennæ are sensitive organs of touch with which the wasps communicate with one another. These organs a wasp keeps clean by drawing them through a “ brush and comb ” structure on the front legs. As with the bees there are three castes of individuals—males, females and workers.

In the first warm days of spring, the queen wasps, that have hibernated through the winter, are busy finding suitable spots for nest-building. The place chosen by a queen is generally a hole, which may be a mouse or mole run or a hollow among tree roots. The queen begins making the nest by rasping with her mandibles small particles of wood from the surface of wooden posts and palings. She moistens this material with saliva, works it up into a pellet and carries it off to start the nest, which she does by fixing it to a firm support at the roof of the hole. More and more pellets are added to form a short pillar, and below this is fixed a small cup-shaped cover. Hanging below the cover the wasp builds a small platform and, to its under surface, fastens a few paper cells in each of which she lays an egg.

In about a week the eggs hatch into legless, maggot-like grubs, which hang head downwards from the walls of their cells. They are preserved from falling because the ends of their bodies are still tightly tucked into their egg-shells which are glued to the tops of the cells. The wasp first

feeds the grubs from her mouth on nectar and honey-dew, and later with the juices of caterpillars, for wasps are essentially carnivorous. In a short time the larvæ are fully grown and each then spins a silken cocoon and becomes a pupa. From the pupæ emerge adult worker female wasps, but, though females, they are unable to lay eggs.

The workers soon become busy in feeding the grubs hatched from later eggs, in making paper and cells, and in enlarging the nest. The queen now ceases working and devotes all her energies to stocking with eggs the cells prepared for her. She no longer goes out to seek food but is fed by her attendants. Tier after tier of cells is built below the first, one being suspended from another by a central pillar as well as by other pillars at different points. The cover is constantly enlarged with layers of paper until, finally, the whole comb is completely surrounded except for a small opening at the lower end. As more room is required for the nest the hole is enlarged, the workers carrying out the earth and dropping it some distance away. A narrow space is left all round the pear-shaped nest separating it from the earth. The wasps crawl down this space and enter the nest from below.

The population of the colony continues to grow and a prosperous one may contain from eight to nine thousand cells. As each cell is used more than once, some sixteen thousand wasps may be reared in one nest during a season.

As the colony grows, male wasps and new queens are reared in special cells. These queens also become the parents of large families all of which remain in the same nest. Unlike the drone of the hive bee, the male wasp does his share of work in the colony—cleaning the nest, removing the dead bodies of wasps, and so forth.

All through the summer, the wasps work from sunrise to dusk searching for food to feed the grubs, but as the days and nights become colder, a change comes over the colony. The young queens leave the nest and retire to sheltered nooks to hibernate. The workers kill off the larvæ still in the cells. They may then have a few days of leisure which are spent in foraging for food, but the first frosty night kills all the wasps that remain.

The Hornet.—This large wasp is not among the common ones to-day. Its life history is similar to that of the common wasp so there is no need to describe it in detail. The hornet is about an inch long; the velvety antennæ are pale brown; the head and face are yellow, except that between the tips of the dark compound eyes there is a connecting patch of brown. The thorax is all brown; the first three segments of the abdomen are mostly brown and the remainder mostly yellow.

The nest of the hornet is built usually in a hollow tree, but sometimes

in the roof of a barn. The walls, like those made by the common wasp, consist of paper which, however, is coarser and mostly of a yellow colour. The common wasp gets its pulp from sound wood, the hornet from soft, decayed stuff. The interior arrangements of combs and cells are similar to those of the common wasp, but on a larger scale.

The Large Garden Humble Bee.—This is the commonest of the humble bees. The queen makes her nest underground where, towards the end of summer, there is a colony of some two hundred workers in addition to many drones and new queens.

The garden humble bee is black with a yellow band across the thorax, another across the middle of the abdomen and a yellow patch at the end of the body. The sting of the queens and workers has no barb. The queen, who collects the food at the beginning of the formation of the colony, is provided with "pollen baskets."

When a young queen comes from her winter quarters she probably chooses the deserted hole of a field-mouse for her nesting-place. With the bits of grass left behind by the mouse, she weaves a nest shaped like a hollow ball and having one small opening.

From the catkins of the willows, the flowers of the blackthorn and other early spring flowers, the queen collects pollen and nectar and, on returning to the nest, spreads the pollen moistened with honey on the floor. She then lays a batch of, perhaps, eight eggs on this paste floor, and encloses them in a low wall of wax which exudes from under the edges of the upper plates of her abdomen. She then roofs over the cells and, in order to keep the eggs warm, she broods over them by day and night, only occasionally leaving them to get food. To provide herself with a store of food for night use, she places close by the brood chamber a small waxen cell which she fills with honey.

In from four to five days legless grubs hatch from the eggs and begin to feed on the paste floor. From time to time the queen supplies the grubs with a mixture of chewed pollen and honey which she passes through a small hole torn in the roof.

The grubs are full-grown in a week, when each spins a cocoon and pupates. The queen removes the waxen covering and broods over the cocoons for a little less than a fortnight, when emerge worker bees which in a day or two go out to forage for themselves.

As soon as the first grubs have spun their cocoons, the queen makes new cells and lays more eggs. This business goes on throughout the season, so that batches of bees emerge at intervals.

The workers store honey in cells and in the old cocoons which they line with wax; some cells are specially made to contain pollen. The

amount of stored honey is small as it is not provided for winter use but for the needs of the grubs.

Drones and queen bees as well as workers develop during the season. The drones leave the nest and forage for themselves until the time comes when they mate with the young queens. Only the newly-fertilised queens survive the winter ; the old queen, the workers and the drones all die.

Robin's Pincushion.—This is the name given to the mossy balls of green and red often found on the shoots of the wild rose. They are known as Bedeguar Galls and are produced by minute, black, gall-wasps. The female gall-wasp pricks a leaf-bud and lays her eggs in it with her ovipositor. When the tiny grubs hatch out, some irritation appears to prevent the bud unfolding its leaves, and in their place moss-like threads or " pins " are formed. The whole gall increases in size and becomes hard. When a " pincushion " is cut through the middle, the numerous larvæ will be seen, each in a separate cell formed by its feeding. The larvæ live in the gall during the winter and pupate in the spring. The gall-wasps which bite their way out are no larger than small gnats.

The Leaf-cutter Bee.—This bee lives a solitary life. It provides cells and a little store of food for its young, but there is no social life with busy workers. In appearance these bees are much like hive bees, but are stouter and darker with whitish patches of down on the body. The female hibernates during the winter and at the approach of spring begins nest-building. The nest may be in the soil, in a hollow stem, or in a cavity in a wall.

The female cuts out circular and oblong pieces from the leaves of many garden plants, more especially the rose. She clasps a leaf between her legs and bites through it quickly with her mandibles until a portion of the right shape has been cut. She transports the fragment tucked up under her legs to the place selected for a nest and uses it in the construction of the cells. These are made entirely of pieces of leaves glued together by a waxy secretion, and are thimble-shaped. Oval pieces are used for the sides and round pieces for the bottom and the lid.

When a cell has been completed, it is filled with a mixture of honey and pollen and an egg is laid upon the surface. Then the cell is capped. Other cells are built closely upon the first, until there are about six in a pile. The larvæ which hatch from the eggs are surrounded by the food provided by the mother. They grow, pupate and eventually emerge as leaf-cutter bees. There is a considerable interval between the construction of the first and last cell, but the bees that develop first in the lower cells wait until they can escape. It is the top cell that is vacated first and then the others in turn.

PLATE 52. STAGES IN THE LIFE HISTORY OF SOME LOWLY SCAVENGERS

The House-fly.—This insect belongs to the *Diptera*, or “two-winged” flies, which have the second pair of wings reduced to knobs (balancers), yet have a very highly-developed power of flight and of balancing. The house-fly has a dark, ash-coloured body with four black stripes down the front part of the thorax and one along the back part of the abdomen. The large compound eyes are of a dark, red-brown colour. The house-fly does not bite or sting. It has a proboscis, a kind of pump with which to suck up food. When one alights on bread, sugar or other solid food it emits saliva, which partially digests the food, turning it into liquid.

The eggs are laid in damp dust and refuse, and hatch in about two days in favourable weather. The larvæ are white maggots with no legs or eyes, usually finding their food by smell. At the pointed end is a mouth with hooks for tearing off pieces of food to be swallowed. In six or seven days in summer the maggots complete their second moult and the skin hardens into a brown, barrel-shaped *puparium* looking much like a plant-seed. Adult flies emerge in a few days and the females soon lay another batch of a hundred or more eggs.

Most of the flies die in the autumn but some live in sheltered spots during the winter, becoming active in a warm room or in mild weather. Some pupæ are said to persist through the winter, the flies emerging in the following spring.

The danger of flies to human beings lies in the fact that they carry disease germs on their feet and proboscis. The end of each foot has a pair of claws between which is a pad covered with bristles. From these exudes a sticky gum by means of which the fly clings to almost any surface. As the flies frequent spots where decay is taking place, they pick up the germs of diarrhœal types of disease, and convey them to food direct, or to the rims of milk bottles and jugs, dishes, and so forth, from which contamination can spread.

The Burying Beetle.—Amongst beetles which live in the soil, there are some that feed on rubbish, either the dung of animals, or their dead bodies. The burying beetle is an interesting example of one that not only feeds upon dead bodies, but also helps to bury them.

The illustration shows two of these beetles preparing to bury the body of a dead shrew. After making a meal of the flesh, the beetles dig under the body, using their legs and heads in the work. Soon a shallow pit is made into which the body sinks. The digging is continued until

the pit becomes a hole, deep enough to enclose the animal. The female beetles now lay eggs inside the carcase, which they then cover with the soil that was thrown out. The eggs hatch and the grubs feed on the flesh. In due course they burrow into the soil, become pupæ and, later, adult beetles.

The burying beetle is black with two orange bands on its elytra which are truncated and do not cover the whole abdomen. It has a strong, flat head and club-shaped antennæ. The latter are used not only for feeling, but are the chief means by which the beetle smells out the dead bodies. The burying beetle is often known as the *sexton beetle*. It is a strong flier, thus being able to reach carcases speedily. When alarmed, the beetle emits an evil-smelling, black fluid from the mouth. It can also make a creaking sound by the rubbing of a bar, running across the ends of the elytra, against two bars arranged longitudinally on the back of the abdomen.

The Silver-fish.—This small insect belongs to the order *Aptera*—the “wingless family.” It is about a $\frac{1}{2}$ in. in length, and is notable for its glossy, silver-white appearance (due to a covering of scales), a quick, wriggling movement and a general similarity to a diminutive shrimp. It has six legs, two long, stiffish antennæ and, projecting from its tail, three spikes of a similar type.

The insect receives little attention in the household, mainly owing to its small size and its habit of dwelling in colonies in dark, undisturbed corners, particularly those of old drawers, disused cupboards and beneath linoleum, where there are crevices to provide suitable homes. In every case the formation of a colony is due to the existence of a supply of starch or sugar in one form or another. Collars, wall-paper, string, backs of books, curtains and aprons are among the host of things which, in their texture or in the starchy material used for binding parts together, are affected by the ravages of the tiny scavenger. The destruction wrought is due to the quest for food. For the purpose of extracting every vestige of starch from objects seemingly indestructible by such a harmless-looking creature, nature has provided the silver-fish with a pair of powerful, lobster-like claws. With these it nibbles tirelessly at edges of articles rendering them in a short space unfit for repair.

The female lays her eggs in a tiny crevice and within a few days the young are hatched in the form of miniatures of the adult stage, which is reached through a succession of growth periods, each ending in skin-casting.

The House Cricket.—This is one of the leathery-winged insects belonging to the order *Orthoptera*—“straight-winged,” a term alluding to the fan-like closing of the hind wings into straight segments. It does not

have a complete metamorphosis, the young from the eggs being small editions of the parent but without wings, which do not develop until the third or fourth moult. There is no quiescent pupal stage.

Crickets often make their home under a warm hearth. Their bodies are flattened sideways and they are thus able to squeeze themselves into narrow cracks. The hind legs are long, for jumping; sometimes the insects fly about a room. The forewings are bent in such a manner that one portion of each lies flat along the back, the other vertically against the side of the body. Especially at night the male makes a chirping sound, which is produced by the rubbing together of the wing-covers. On the underside of one wing-cover are many tiny ridges which are rapidly scraped over a smooth projecting ridge on the other wing-cover, thus throwing the wing into vibration and causing a musical note. It is known as the *organ of stridulation*. There are also, in both sexes, organs of hearing on the fourth joint of the first pair of legs.

Crickets are greyish-brown in colour. Their food consists of crumbs and other refuse which may be left about. The female lays her eggs in a crack, putting each one in place with her ovipositor.

The Garden Ant.—Ants belong to the same order of Insects as the bees and wasps, that is the *Hymenoptera*, “skin-winged,” which comprises insects with two pairs of membranous nerved wings. Only the male and female ants have wings, and those for a short period only, but their two pairs of wings, like those of the bees and wasps, are hooked together in pairs when in action. Ants also belong to the class *Aculeata*—“having a sting.”

The garden ant, also known as the black ant, is found in abundance in most gardens. Its general appearance is black, but it is really a blackish-brown. Like all the ants they are social, living together in large colonies underground. There are three distinct castes—males, fertile females (queens), and infertile females (workers).

The males, which appear only in summer, are winged, and have their sense and reproductive organs highly developed, the antennæ relatively long, and the head smaller than the workers. The queen, which is larger than the members of either of the other castes, has well-developed mandibles and reproductive organs, with short antennæ and stout legs. In the workers the body and thorax are relatively much smaller, the head large; the antennæ, mandibles and legs well developed. Both the workers and queens have stings.

After the “marriage-flight” of the young males and females, which takes place in late July or in August, the males die; an impregnated female on descending to earth strips off her wings with her hooked feet,

and digs for herself a small chamber in which she lies until her eggs are mature. She uses her jaws in scraping away and carving out the earth ; the front legs also are used in scratching out the soil. The eggs are minute objects not to be confused with so-called " ants' eggs " which are the cocoons of ants containing the pupæ. When the eggs hatch, the queen feeds the larvæ with her saliva. It is not until the workers have emerged from the pupæ, made their way to the surface, and begun to forage for themselves, that the now emaciated queen can cease to rely entirely on her own efforts. From this time onwards, the workers feed her by regurgitating liquid food from their own crops and offering it to the queen on their tongues. The queen's business in life is to lay eggs. The workers undertake the whole management of the nest, feeding, cleaning, and tending the young, even helping them through their moults and carrying them from place to place. They carry the eggs dropped by the queen to a special chamber, where they lick them regularly, thus keeping them clean and preventing the growth of fungi.

The larvæ have no legs and cannot move. They are kept clean by licking, fed on regurgitated liquid, and sometimes carried from one part of a nest to another, either to a warmer spot or to a deeper chamber where there is more moisture.

As the time of pupation draws near, the workers bury the larvæ or cover them with earth. The larvæ weave for themselves silk cocoons in which they pupate. The workers then remove all the earth, clean the cocoons and occasionally move them to new quarters.

When it is time for the ants to emerge, the workers assist by tearing open the cocoons on one side. They then help each " callow," as it is called, to unfold its legs ; they clean it and feed it until it is able to shift for itself.

The nest is usually underground beneath a large stone or tree or in a heap of soil. It consists of a number of separate " chambers " connected by a wonderful system of " galleries." In some nests special " stables " are built for keeping *Aphides*, which are captured by the ants and kept like cows for the " honey-dew " exuded from the ends of their bodies when actively engaged in feeding. The ants stroke the *Aphides* with their antennæ and this action induces the insects to give out the sweet juice which the ants lick up.

Ants also visit flowers for nectar, kill flies and other insects for their juices and sometimes invade houses for such sweets as honey, sugar and syrup.

An ant is unable to eat solid food so, when feeding on a fly, for instance, it packs the body into a little pocket underneath the mouth and squeezes out all the juice that it contains.

Many ants are left behind to look after the nest : they do not go out to seek for food and are themselves fed by other ants. An ant that returns to the nest with a cropful of juice regurgitates the food into its mouth and presents its tongue to a hungry worker, which quickly satisfies its needs.

The nests remain from year to year, continuously increasing in size and in the numbers of their inmates. During the winter the ants retreat farther underground and go into a state of torpor.

The Cockroach.—Cockroaches infest kitchens, pantries and bake-houses, and are common in houses where there are crevices and cracks in the floor. This animal is, like the cricket, a member of the *Orthoptera*. The wing-covers of the male are short and leathery ; the transparent flight-wings are folded fanwise under them when not in use. The wing-covers of the female are very small and she has no flight-wings. The curious position of the head, which is turned downwards, can be seen in the side view of a male illustrated on the Plate.

A cockroach is frequently called a black beetle, but this name is misleading because not only is a cockroach of a dark brown colour, but true beetles differ from cockroaches in their structure and life history. The cockroach does not have a complete metamorphosis. The female produces eggs in batches of sixteen, each batch enclosed in a little horny, reddish-brown purse carried at the end of the abdomen. The egg-case is hidden by the female in a warm crevice, and the young which hatch out are almost white at first except for their shining black eyes. These young are much like their parents (wherein they differ from the larvae of beetles) but are without wings. They run about and feed freely from the first. There is no resting-stage as a pupa. The young insect moults from time to time as it increases in size, a new coat, at first soft and wrinkled but rapidly stretching and hardening, having previously formed beneath the old one. Shortly before the last moult, the wing-covers and wings begin to appear. It takes five years for the insect to attain the form and size of an adult.

A full-grown cockroach has a flat, loosely-jointed body which enables it to squeeze into a narrow crevice and hide completely during the day-time, coming out to feed at night.

It has a pair of long, thin, flickering antennæ which are organs of both touch and smell. The legs end in two claws with sticky pads between, so that it is able to run up walls and over smooth surfaces. It has powerful mandibles with horny teeth. Besides eating crumbs and other starchy food of which it is fond, it will chew shoes, leather book-bindings, clothes and many other things. When disturbed it emits a disgusting, strong-smelling fluid from a pair of glands on the upper side of the abdomen.

Few animals will touch cockroaches but it is said that hedgehogs will feed on them. It is *not* true that they are eaten by tortoises, which are sometimes sold for that purpose. Tortoises are strict vegetarians, living on lettuces, carrots, cabbages and such food.

PLATE 53. STAGES IN THE LIFE HISTORY OF SOME LOWLY DWELLERS OF THE GARDEN

The Ladybird.—Ladybirds, the birds of Our Lady, are small beetles constituting the family *Coccinellidae*—"scarlet-coloured." They are notable for their oval, domed bodies having bright and 'conspicuous colouring and for the absence of any attempt at concealment. Their warning colours suggest that they are inedible. They are unpalatable insects which exude from the joints of their legs a yellow fluid having an unpleasant smell.

Ladybirds are among the most popular of insects, and they are of incalculable value from the economic standpoint, for both the larva and the imago feed upon *Aphides*. The two best known in Britain are the two-spotted ladybird and the seven-spotted ladybird.

The ladybird deposits her orange-coloured, spindle-shaped eggs in clusters upon plants infested by *Aphides*, and the little active larvæ, on emergence, fall immediately upon their prey. As they grow they become a more slaty colour with small red and white spots along the sides. In from five to six weeks they are full-grown; the posterior end of the body is attached with a sticky fluid to the surface of a leaf and the skin shrinks back, revealing the yellow pupa, which darkens towards black and after about eight days changes to the adult insect. Within a short time a second brood appears and the winter is passed in the adult stage, the beetles congregating in numbers beneath the bark of trees or in similar sheltered places.

The Green-fly or Aphis.—There are many kinds of *Aphides*, some green, some black, some woolly, all causing what are known as *blights*, that is, they multiply rapidly in warm weather, especially where the quick growth of young shoots has rendered them vulnerable to attack, and in a few days cover large surfaces, causing serious injury. The *Aphides* pierce the skin of leaves and stems, near the tips of young shoots particularly, and suck the sap. Many kinds secrete a sticky, unpleasant juice (e.g., on sycamore and lime) which possibly interferes with the function of leaves by clogging the pores. The proboscis is a short, sharp, piercing tube, capable of suction.

Eggs hatching in the spring from a batch laid in the autumn develop

in a few hours into wingless adults, which feed actively. From the end of the body they produce on an average two similar offspring a day, and these in their turn go on multiplying at the same rate under favourable conditions.

This type of reproduction takes place without any male forms being needed, that is, the females produce unfertilised eggs which hatch. From time to time, especially if food is getting scarce, a few winged females appear, and these migrate to new pastures and so extend the "blight." They do not reproduce their kind so rapidly as the wingless forms, and have a more gradual growth, often protecting themselves by a silken web or by curling up leaves.

In the autumn, wingless females and winged males appear. These unite to produce fertilised eggs, and it is these eggs, laid amongst the bud scales, that survive the winter.

Thus, the rule is rapid reproduction of summer broods from unfertilised eggs under favourable conditions, but slower reproduction of smaller numbers of fertilised eggs, so ensuring survival under winter conditions.

The Crane-fly.—This large, common, brown fly is often called the "daddy-long-legs;" both names referring to the length of the imago's legs. These long legs serve a useful purpose when the fly is hovering about the grass preparing to lay its eggs; also, as it is a heavy-bodied insect, its long legs act as buffers when alighting. The crane-fly belongs to the class of insects called *Diptera*—"two-winged." This class is characterised by the possession of a transparent pair of forewings, while the hind pair are replaced by a pair of small, dumb-bell-shaped organs known as *halteres*, which are very clearly observable in the crane-fly. Experiment has shown that the halteres serve as balancers during flight, and it is further believed that they act as organs of hearing.

The female has a more slender body than the male, and has at the end of the abdomen two pairs of pointed projections with which she can grasp each egg and push it into soft soil. In early autumn she deposits from two to three hundred black, shiny eggs which are laid separately.

The larvæ, or grubs, which hatch out, live through the winter in the soil and are known as *leather-jackets* on account of their tough, leathery skin, which is of a muddy grey colour. The grubs have sharp-toothed saw-like jaws, with which they gnaw grass roots, rhizomes, tubers, bulbs, etc., often doing great harm in cornfields and on cricket pitches and golf greens. The leather-jacket is legless and wriggles its way through the soil, keeping the tail in such a position that air can reach the breathing-holes at the end of it. In spring, the grub becomes a pupa from which a

crane-fly emerges, and another brood of eggs is deposited and hatched to live through the summer. So it is that leather-jackets are active and injurious during most of the year. They are inactive in very cold weather.

The pupæ damage smooth lawns by the holes they make in order to set free the crane-flies. The pupæ pull themselves to the surface by hooks on the hind end. These hooks prevent them from slipping back, and as there may be hundreds of pupæ near together, they riddle the lawn with holes. The pupa bears on its head two little respiratory horns.

The Garden Spider.—Spiders belong to the *Arthropods*—"jointed-feet," and are classed as *Arachnids* for they differ in many respects from insects. A spider's body is divided into two parts. The forepart, the cephalo-thorax (joined head and thorax) bears the eyes of which there are usually eight, and the four pairs of legs. The third and fourth pairs of legs end in small claws which are capable of clinging to the thread and bearing the spider's whole weight. At the tip of the underside of the swollen abdomen in the female are the spinnerets, the surfaces of which are covered with tiny pores through which are exuded gummy threads that immediately harden in the air into fine, silken threads. As many as 600 glands open on separate little projections on the six spinnerets. The projections vary in size, some exuding thicker threads than the others. The stronger threads used in "spinning" do not consist of several threads woven together, but of double or sometimes fourfold threads emitted from separate pores and adhering throughout their length.

The spider has no antennæ but it bears in front of the head two small pairs of limbs. The first pair, called *falces*, are sickle-shaped and are fangs through which poison is exuded to paralyse the prey. The second pair are the *pedipalps*, "squeezing-legs," by which the juices are squeezed out of the victim's body into the spider's mouth. Both thus serve as jaws.

The spider breathes air by means of respiratory organs called *lung-books*. On the underside of the body are two transverse slits which open into sacs containing little plates arranged somewhat like the pages of a book, hence the name lung-books. They are copiously supplied with blood and can move apart or keep close together. The air drawn in between the plates oxygenates the blood. Besides the lung-books there are air-tubes in the body which open by a single spiracle behind the lung-books.

The best known of the garden spiders is the cross spider (*Epeira diademata*) which is of a brownish-yellow or reddish-brown colour marked on the back of the abdomen with streaks and dots of white arranged in the form of a cross. There are other *Epeiras* which are nearly as common, but rather smaller and with different markings. The word

Epeira means "to fasten together in rows," and this name is given to the class of spiders which weave circular webs consisting of radial threads crossed by a spiral one.

In October, the female cross spider lays a number of light pink eggs which she wraps in a loosely woven cocoon of yellow silk about $\frac{1}{2}$ in. to $\frac{3}{4}$ in. across, through which the eggs are just visible. The cocoons are hidden amongst dead leaves, evergreen bushes, in crevices of doors and window-ledge, where they usually remain until the warm spring days. Then the young spiders hatch out, and, spinning their first threads, descend from the cocoons. They cannot feed until they have shed their first skin and they disperse only after this has taken place.

Their first adventurous journey has often been described. They will stand on the edge of an exposed bush and, arching the body and standing on tiptoe in the breeze, will send out streamers of thread which catch the wind and, like thistledown, blow away with the young spiders attached by their claws. Presently the little spiders settle down, spin minute but perfect webs according to the ancestral pattern and catch small flies. As they feed they grow, shedding their skin and appearing a little larger after each cast, until by the end of the summer they are full-grown. Though the majority die, some mature spiders survive the winter and may live for two or three years.

The Garden Snail.—This slow-moving creature is a mollusc ("soft-bodied" animal) which belongs to the class of *Gastropods*—"stomach-footed." It consists of a soft, unsegmented body, which is produced ventrally into a foot. It is protected by a shell formed by the activity of part of the mantle which covers the body. The shell is in one piece and is spirally coiled. The head bears two pairs of tentacles; at the tip of each of the longer and upper tentacles is an eye. The hollow tentacles emerge by turning inside out, and are drawn in again by the tip first.

The snail crawls about by wave-like contractions of its muscular foot. As it does so, it discharges a mucous substance from a gland which opens at the front end of the foot in a groove just below the mouth. The mucus forms a smooth path over which the snail can glide. It hides during the day in damp places for it is unable to withstand heat and dryness. At night or on showery days it feeds upon vegetation, which it rasps into small particles by means of a toothed *radula* or grater, and then swallows. The radula has 107 teeth in each row, and 145 rows; hence it can do much damage to growing plants. The snail breathes air. The mantle fold under the shell encloses a lung chamber with blood vessels in its walls. The chamber opens to the exterior by a respiratory pore on the right side.

In late autumn, when food plants have died down, the snails retire

into crannies to hibernate. Often large numbers are found attached to one another, probably a useful habit, not so much for keeping warm, as because suitable shelter is not easily found. The body is then entirely retracted into the shell, the mouth of which is closed by plates of hardened lime. These are yellowish, with a white porous spot which is supposed to suffice for admitting air.

In the spring, the female deposits in clusters beneath the surface of damp soil, pearl-like, transparent eggs about $\frac{1}{4}$ in. in diameter. In a few days, minute, transparent, colourless snails emerge.

The Large Black Slug.—This slug is common in damp places. It is of similar construction to the snail, except that the shell has almost disappeared, even the trace which remains being concealed by the mantle. The mantle lies on the top of the long body, its margin being fused all round except at the respiratory aperture which leads into the lung cavity. There is a distinct groove running parallel to the edge of the wrinkled body marking off the sole of the foot. This border or foot fringe is marked by vertical lines alternately black and dusky. In most respects the habits of the black slug are like those of the garden snail. It has similar tentacles and a radula with many hundreds of horny teeth. It secretes a copious flow of mucus from the foot to make a trail along which to glide. When alarmed it withdraws its tentacles, so protecting the eyes, and contracts the fore-part of its body as a snail does when withdrawing into its shell.

The large black slug generally lies hidden during the day, coming forth to feed on plants at night.

Slugs deposit large numbers of eggs, perhaps 400 of them, in batches. The young slugs hatch out in about two months; they do not attain their full size until the second year. They hibernate in the soil during the winter.

The Earwig.—This flat, dark brown insect which may often be seen running swiftly about the garden belongs to the Family of *Forficulidæ*, a name which refers to the pair of "little scissors" or pincers, at the end of its body. Earwigs hide by day under stones, among plants or in any suitable dark crevice. At night they roam about, feeding upon decaying vegetable matter, tender leaves, fruit juices, flower petals and small grubs. They are particularly fond of dahlia flowers and in a greenhouse may do much damage to the petals of chrysanthemums.

The front pair of short, horny elytra act as a sheath to the transparent pair of flight-wings which are very thin and delicate. Few people have seen an earwig in flight, but those who have tell us that when an earwig alights it shuts up its hind wings like a pair of fans, folding each over

twice and then, turning up its "tail," uses its pincers to tuck the folded wings under the elytra. Some naturalists claim that the pincers are also used for catching prey, but this is not known for certain. The pincers of the male are longer and more sharply curved than those of the female.

Earwigs hibernate in colonies underground during the winter. In spring, a female deposits her eggs in masses of fifty or more in a small hollow which she makes in the ground, and she guards them with care until they are hatched. The young, which emerge in about three weeks, are nymphs, small editions of the parents but at first pale in colour and wingless. The nymphs remain for some time with their mother, hiding beneath her body, much as chickens hide beneath a hen.

The Lacewing-fly.—This insect belongs to the order *Neuroptera*—"nerve-wing," a large Family usually possessing biting jaws and four nearly similar wings with complicated veining. A very common feature of the forewings is the number of short nervures that run at right angles to the front edge upon which they rest. The wings are held roof-wise over the back during rest; the larvæ are generally of the active, predacious type.

The lacewings belong to the class *Chrysopidæ*—"golden-eye."

The adult lacewing, often found on rose bushes, lime and other trees, is a frail insect, with very much veined, delicate wings and long antennæ. It is of a greenish colour with large golden, metallic-looking eyes. The egg-laying habit of the female is unique. With each egg a sticky substance is exuded, which is applied to the leaf and then drawn out as a thread; it hardens in the process and the egg is carried on the top of it.

The grubs are greenish or pinkish, mottled with brown. They are rather stout creatures with tapering bristly bodies and prominent sickle-shaped jaws, with which they pierce the bodies of their prey and suck up the juices. Both the adult and the larva feed upon Aphides. After an active life lasting about a month, the larva spins a cocoon of silk given out by the tail and becomes a pupa. In this state it passes the winter, the fly emerging in the spring by biting its way through the cocoon with a pair of jaws specially developed for this purpose.

PLATE 54. POND INSECTS

The study of life in a pond gives us a glimpse of a strange little world, almost self-contained, presenting in miniature many of the problems which the creatures in the much wider regions of land and ocean have to solve. It is true that the pond receives its water supply from outside—from rain and drainage—and that the organic matter (such as leaf mould

and animal manure from the fields) which drains into it provides food for the minute, invisible organisms, especially bacteria, which in turn feed the larger animals or provide for some of the needs of the water weeds. It is also true that the animals and plants in a pond depend upon the outside atmosphere for the air they breathe. But in a pond, they live at such close quarters that their inter-dependence and the inter-action of their lives are more readily grasped than perhaps is the case in any other kind of community.

Both animals and plants must be able to obtain food, oxygen for breathing, shelter and safety from enemies, and, in particular, protection for their young stages. In many cases it is also important that they shall have some means of protection or escape if the pond dries up.

Broadly speaking, animals feed on plants, some of them directly, as do the pond snails, tadpoles, and larvæ of some kinds of beetles. Others feed on animals which have been reared on a vegetarian diet. They can feed only on substances which have formed part of an animal or plant body or, as we say, on organic substances. They obtain by this means energy for their activities which has been stored up by plants as it radiated from the sun.

Plants obtain some of their nutrition by the activity of their green parts, which take up the sun's energy, and use it to convert the gas carbon dioxide, with water, into carbohydrate food material. They are to this extent independent of animals. But they also require nitrogen in the form of nitrates. This they obtain through the agency of bacteria, which obtain it partly from the air directly, and partly by decomposing the dead bodies and waste matter (excretions) of animals. Thus plants take toll of the animals in water. (The bacteria themselves are regarded as plants.) Since the bodies of plants eaten by animals contain nitrates, this series of inter-actions between plants and animals is referred to as the *nitrogen cycle*. This cycle operates everywhere, but is seen particularly clearly in a pond.

Yet another interchange takes place between plants and animals in a pond. Both require oxygen to breathe, and both obtain it in solution in the water. Much of this oxygen passes into the water from the air above, through disturbances of the surface, and through rain. In running water there is more possibility of admixture with air than in still water. But supplies obtained in this way are small. It so happens, however, that in manufacturing carbohydrates, plants give out oxygen as a by-product. (This is a distinct process, in no way connected with their breathing.) This can be used by animals for breathing. Now both animals and plants give out carbon dioxide as a result of breathing, and this is available for

plants, which need it for the making of carbohydrates (*photosynthesis*). Thus there is a second cycle of inter-action, the *oxygen-carbon-dioxide cycle*. This also applies to terrestrial life but is very clearly seen in a pond.

Now it will be seen that, under these circumstances, the problem of obtaining sufficient oxygen may be a difficulty for plants and animals, and so may the question of the nitrate supply. Hence, if a pond community is to flourish, there must not be too many animals to feed on the plants. The number of plants is less important, since they are contributing both oxygen and nitrates to the animals. The proper relation between the two is referred to as *the balance of life*.

Since the oxygen supply dissolved in the water is limited, it will be seen that if some of the animals can obtain oxygen from the atmosphere, it will lessen the demand upon the water, and so make it possible for a larger number of animals to dwell there. This adjustment has actually been made. The pond snails have developed a breathing system suitable for dry land, and have then gone back to live in water, but they still come to the surface to breathe. All insects found in ponds are also immigrants from land. So, too, are the adult frogs and newts which return to the ponds for the breeding-season. Some of the insects have become adapted to breathing under water, and thus they use the dissolved oxygen, but others have retained the habit of breathing atmospheric oxygen and come to the surface, as the snail does, to breathe.

Here a word must be said about the importance of the *surface film*. Owing to the difference in tension between the water and the air, the surface of the water is stretched, so as to form a thin water membrane so strong, that by filling a glass of water from a tap very gently, one can fill it beyond the surface, the surface film preventing it from spilling. Many pond creatures are able to glide on to the surface film and suspend themselves from the underside of it, sometimes by means of a special structure. But the pond snails suspend themselves by the foot, while they penetrate the film at one small spot and protrude a short tube or valve, into which they can suck air without the water entering. This property of the surface film, and the delicate devices adopted for taking advantage of it, are of the utmost importance in enabling these animals to obtain fresh air for breathing.

The Long-bodied Dragon-fly.—The dragon-fly belongs to the order *Odonata*—"toothed," from a tooth-like thickening in the front edge of the wing. Dragon-flies are noted for their brilliant colours, skilful flight and graceful form. The body is long; the two pairs of hard and glassy wings are approximately alike and have a large number of nervures. The

head is freely movable and carries a pair of very large compound eyes, a pair of minute, bristly antennæ and strong biting jaws. The other mouth parts are modified to form a kind of trap for catching the small insects upon which dragon-flies feed. The short spiny legs are also used for catching and holding insects; they are rarely used for walking purposes.

The long-bodied dragon-fly is one of the kind commonly called a "horse-stinger" or a "devil's darning needle," though no dragon-flies sting.

The long-bodied dragon-fly is a deep, dark greenish-blue, with bronze and gold lights in the sun, yellow spots on each side of the abdomen in the female and green in the male. The eyes are a deep greenish-blue.

Eggs are laid singly on water-plants by means of an ovipositor which acts much like a hypodermic needle. The larval stage is spent under water, breathing taking place by means of thin-walled pouches in the hinder end of the food canal. Water is sucked into this tube—the rectum—and dissolved oxygen withdrawn by the pouches.

The full-grown larva is an ugly, drab, slow-moving creature, with a hammer-shaped head and large eyes. (In its early stages it is a translucent green.) Like all dragon-fly larvæ, it is carnivorous, feeding chiefly upon May-fly larvæ, mosquito larvæ, tadpoles, worms and the like. Although it usually crawls about, sometimes it swims with a curious jerky movement due to the sudden expulsion of a jet of water from the rectum.

The larva obtains its food by shooting out its lower "lip," which forms a "mask" under the head.

The "mask" is a structure developed from the lower "lip" (really the third pair of jaws) and is peculiar to the larvæ of dragon-flies. It is an arm-like organ that bears at its extremity a pair of curved, tooth-like forceps with which the prey is seized; when folded up, the lip-arm completely covers the underside of the head and part of the thorax, hence its name of "mask."

There is no pupal stage, but the skin is shed several times and in the later stages the rudiments of wings appear, growing larger with each successive moult. The fully grown nymph crawls up a stem out of the water, and, splitting its skin for the last time, emerges as the dragon-fly.

The skin splits down the back of the thorax, the body inside swells and widens the crack, which extends farther, allowing the head and wings to be freed. Then the legs are drawn out by strong movements of the parts already free and, finally, by holding on to the old skin with the legs, the abdomen is curved away from it and drawn out.

The body is still compressed and the wings crumpled. In a short time the wings expand and they begin to obtain their iridescent colouring.

The body and wings take some time to harden, and it is probable that a pumping of liquid takes place to distend and shape the wings and abdomen, and that later this liquid dries up. Liquid has been observed dropping away from the abdomen as it gradually gets thinner. The whole process takes about three hours. Towards the end of this time the abdomen assumes its brilliant colouring.

It is curious to see the flies resting for a long time apparently asleep but with wide-open, staring eyes. They feed on the wing like swallows or hawks, with a swift, strong flight.

The Great Water Beetle.—This, the largest and most ferocious of pond dwellers, is known as *Dytiscus marginalis*—"the bordered diving beetle." Although breathing air like other beetles, the entire structure of the great water beetle is adapted to living in water. Only occasionally does it leave the water to fly to another pond. The "margin" has reference to the light-brown band which runs round the edge of the olive-brown body, and down the outer margin of the elytra. The female may generally be distinguished by the grooves on the wing-covers; the male has enlarged joints on the front pair of legs, which act as suckers to be used by the male in holding the female.

Between the wing-covers and the back is a reservoir of air into which the spiracles open so that respiration is constant. The supply of air is renewed by the beetle coming to the surface of the water and protruding the tip of the abdomen. The wing-covers are slightly raised and the impure gas is replaced by a bubble of fresh air; the wing-covers are then lowered and the "little diver" plunges again into the depths.

The great water beetle is carnivorous, feeding on larvæ, worms, tadpoles and numerous other inhabitants of the pond. The first two pairs of legs are used as grasping organs, the front ones in particular serving to seize and hold the prey, which is then torn to pieces by the powerful mandibles. The third pair of legs is specially adapted for propelling the smooth, boat-shaped body through the water. These legs are provided with fringes of stiff hairs, which become rigid when forced against the water in the back stroke, but bend and pass unresistingly through it when drawn forward again. The beetle cannot remain at the bottom of a pond except by swimming about or by clinging to weeds. It is lighter than water and it floats to the top.

In March or April the female lays her eggs in incisions which she makes in the submerged stems of pond-weeds with a special sharp instrument, the ovipositor, enclosed in the abdomen. The larvæ hatch out in about three weeks. A larva may be recognised by the "S" shape it assumes when suspended in the water and by the broad, flat, triangular head with slender,

curved, pinching jaws and eye spots at the anterior angles. Each mandible is grooved on its inner side, the groove being converted into a tube by a membrane which covers it in. The larva sucks the blood of its prey through the hollow mandibles which fit into the corners of the mouth. In order to catch its prey the larva lurks in the shade of weeds with its jaws open. Its sandy colouring and still posture make it inconspicuous. When a small worm or soft-bodied insect comes near it, the larva makes a sudden dart and closes its jaws upon the prey, then sucks the juice and releases the shrivelled remains. Its position, head downwards in the water, with the body curved, the head slightly bent downwards, and the long, thin legs and open jaws outstretched, is very characteristic. If disturbed, it moves through the water by a sudden violent contraction of the whole body, which shoots it to some distance. It is so quick that the actual detail of the movement cannot be easily detected.

For breathing, the larva is provided with two fringed appendages which it presses against the surface film of the water to keep it afloat. The tip of the abdomen, which it protrudes, is pierced with two spiracles which lead into the two main air-tubes of the body.

The larva is full-grown in about six weeks, when it leaves the pond, burying itself to pupate in the soil on the banks. The imago emerges in about two weeks, if the pupa is formed in the middle of the summer, but if towards autumn, it will remain a pupa until the following spring.

The great water beetle is an instance of an insect highly adapted for a life on land, returning to the water and spending the whole of its life there, except for the pupal period, yet remaining dependent on the air above the pond for breathing.

The May-fly.—May-flies belong to the insect order *Ephemeroptera*, the name having reference to the fact that the life of the imago is ephemeral—"lasting but a day." The life may be no longer than half an hour, or at most during the short hours of a summer night. It is so short that the insects take no food and their mouth parts and food canal are functionless.

The May-fly has minute antennæ, large, triangular, much-veined forewings and small hind wings; long styles trail from the last segment of the body; the slender front legs project like antennæ, and the whole appearance is frail and light. May-flies usually swarm in large numbers when they appear, and their dancing flight is very characteristic.

The eggs are laid in water and give rise to larvæ which are green and transparent but grow darker and more opaque, with each moult. The larva usually burrows in mud and conceals itself in a little tunnel, though it can swim. It has prominent, quivering, tracheal gills of leaf-like shape on each side of the abdomen. The gills are so called because they are

connected with the breathing-tubes or *tracheæ*, and not with the blood system as are the gills of fish or tadpoles. The three long appendages at the end of the abdomen are subsidiary breathing organs connected with the blood system. The larva feeds mostly upon minute organic matter in the mud but sometimes on small living creatures. It remains in this state for about two years, growing slowly and moulting several times. At the end of that period two little bumps appear on the back of each full-grown larva, showing that wings have begun to form and that the grub has become a nymph. When ready to leave the water, the nymph swims to the surface, the skin splits and the winged form rises into the air. This winged form is known as the "Green Drake." It is the stage preceding the last and is unique amongst insects in that the skin is shed in the winged state. The Green Drakes settle on trees, fences and telegraph posts and the skin, splitting, allows the adult fly, the "Grey Drake," to emerge. Then for a short time the May-flies dance together in swarms. They mate; the females drop their eggs into the water, and the flies gradually sink and die.

The principal enemies of the May-flies, when they are near the water, are fishes, especially the trout. The "Green Drake" of the fly-fisher is modelled on the sub-imago of the common British May-fly; the "Grey Drake" upon the adult.

The Whirligig Beetle.—This is a very common small black beetle (about $\frac{1}{4}$ in. long) which occurs in large numbers at the surface of ponds. The name describes the movement, which is the most striking feature. These lively little creatures never collide with one another or with any object that may be on the surface of the water. The sense organs which render this possible are situated in the feelers, which are so developed that the animal perceives in some way the proximity of solid objects. The surface of the blue-black body is extremely glossy, the eyes are large, the antennæ very short and almost rigid, so that they offer no obstacle to the sudden plunges of the beetle into the water and its whirligig movements at the surface. The forelegs are fairly long and adapted for seizing its food; the two hinder pairs of legs are reduced to short paddles. Both the larva and the adult are carnivorous, though they also eat water-plants.

The larva is difficult to find for it may be no more than $\frac{1}{2}$ in. long. It is said to leave the water and pupate among plants in a silk cocoon. The beetles hibernate on the bottom of a pond, an interesting feature, as they are atmospheric air-breathers.

The Gnat.—The gnat is one of the slender-bodied, two-winged, biting flies known as mosquitoes, which in many cases are dangerous

because they can convey in their blood the bacilli of serious fevers. In the case of the common gnat it is the female only that bites, and if she has been visiting dirty, infected places the bite can cause serious irritation and illness. The male lives on the juices of flowers. It may be distinguished from the female by its very bushy antennæ. The mature insects are about $\frac{1}{2}$ in. long, and may be distinguished from the very similar harlequin-fly by the way they stand at rest, with the long *hind* legs raised in the air, curved backwards, whereas the harlequin-flies stand with the *front* legs raised and pointed forwards. The head of the gnat is small, and provided in the female with long, sharp lancets working inside a tube, capable of both piercing and sucking. This tube can be plainly seen, with the flattened end pressed against the skin, as the insect bites. It is possible that at the same moment a drop of poison is injected. The deep booming hum made by the female is caused by the vibration of the wings, and the shriller note, like the plucking of a tiny string, by short, stiff projections on the sides of the body. The buzzing attracts the males, which themselves are silent. Their large plumed antennæ apparently act as receivers to catch this note.

The eggs, which are long and narrow, and very small, are laid on the surface of the water. The female arranges them with her hind legs and glues them together, side by side, making a floating "raft" of eggs. Bubbles of air are held between the tips of the eggs, so that if the raft is upset it floats to the surface again. At the lower end of each egg a little lid opens to allow the larva to hatch, and it slips into the water. As 300 or more eggs are laid by one gnat, it is no wonder that marshy places swarm with these flies. The floating rafts and larvæ may generally be found in the rain-butts.

At all stages in their life it is important that there shall be plenty of air, and there is very little in stagnant water. The gnat larva and pupa, therefore, obtain oxygen from *above* the water. The larva, which is a jointed, slim little creature with a greatly swollen thoracic segment, is provided with a long tube at the end of the abdomen, which it pushes through the surface film of the water, against which it spreads out a ring of small valves. By this means it suspends itself head downwards while it takes in air, often remaining for a long time in this position. In addition to this tube, it has another curious organ, projecting laterally from the last segment of the body, and provided with stiff white bristles and a bunch of soft papillæ. This seems to be a swimming-organ, used to guide the larva as with quick, characteristic jerks of the body it swims through the water. All its movements are sudden and jerky. All the segments are provided with stiff bristles. Round about the mouth these seem to help the larva

by driving in currents of water, containing minute organisms on which it feeds. It grows to a length of about $\frac{1}{2}$ in., shedding its skin three or four times, and then pupates.

The body of the pupa is curved and ends in two little leaf-like projections, and it appears to have an enormous head with two trumpet-shaped "ears" which project above the water. Actually, this is the head and thorax, with the wings and legs of the gnat showing through the skin, and the two projections are new breathing-tubes. The pupa now floats *head uppermost*, not quite passive, for at times it moves jerkily through the water. Finally, the skin splits along the back and the gnat emerges. Many gnats are drowned in the effort to withdraw their legs from the floating pupal skin.

It will be seen from this account why it is that, in fever-ridden districts, whole areas can be freed of mosquitoes by covering the surface of all sheets of water with a film of paraffin. The larvæ and pupæ cannot penetrate it with their breathing-tubes, and so they drown.

The Water Boatman.—This insect is one of the water-bugs classed as *Notonectidæ*—"back-swimmers." These bugs are often seen swimming vigorously on their backs at the surface of ponds and streams. The front pair of legs projects like antennæ and these legs are prehensile for seizing prey, often larger than the bug itself, from which it sucks the juices with its powerful beak.

The hind legs, which are furnished with stiff hairs, are used for propelling the insect through the water. The boatman has a long and narrow body keeled on the back. It is of a bluish-grey colour with some black on the head. Long, delicate flight-wings are protected by horny forewings. The insect frequently flies during the evening.

When swimming on its back, the under-surface of the body is seen to glisten with bubbles of water which are entangled in the hairs that cover it. The air is renewed by the insect floating tail uppermost to the top of the water and taking in air by the spiracles which are placed below the edges of the wing-covers.

The eggs are laid singly in the tissues of water-plants. The young are much like the adults both in shape and habits, but without wings. They are of a pale green colour with red eyes.

The Caddis-fly.—Caddis-flies, which have four wings, are often found in abundance in the neighbourhood of ponds and streams. The forewings are long and narrow, frequently shaded and mottled in grey and brown. The hind wings are more simple and are folded fan-wise under the front wings when the insect is at rest, the latter being laid obliquely over the back and sides. The surface of the insect's body and of the wings is

covered with short hairs. This characteristic has led to the flies being grouped in a special order, *Trichoptera*—"hair-winged."

The antennæ are long and thread-like, and the mouth parts are imperfectly modified for sucking. Many different species of these insects exist, each characterised in its larval stage by a case made of distinctive material taken from the water. The eggs, which are enclosed in a jelly-like substance, are usually dropped by the female into the water. They hatch into minute larvæ which begin to construct a case by attaching bits of sand, stick, leaf, etc., to the body, glueing them together with a secretion of silk produced by salivary glands below the mouth. Some of the larvæ make their case of two oval pieces of leaf stuck together, so that it is quite flat. Others make a raft by sticking on two or three pieces of twig much longer than the tube. Many of the cases have a rough, irregular exterior, but the interior of all is lined with silk.

The larva, or caddis-worm, can project the anterior part of its body, which has a horny covering, but it keeps the soft, hinder part inside the case. The three thoracic segments bear jointed legs on which the larva crawls about. On the first abdominal segment are three little knobs, which are pressed against the tube to keep the larva in place. On the last segment are two tiny hooks, by which it is also hooked in. The remaining seven abdominal segments bear on each side a bunch of white filaments which are the tracheal gills. These absorb oxygen from a current of water kept trickling through the tube.

The larvæ feed mostly upon vegetable matter. On the approach of winter they go to the bottom of the pond and remain there, perhaps feeding occasionally, until the spring, when they become active again.

In early summer the larvæ pupate in their cases. Some close the ends with silk threads, others with bits of material of the same kind as their homes. During the pupal stage, a current of water is kept flowing through the case by the movements of the abdomen. After two or three weeks, the pupa breaks down the entrance to the case with its mandibles (which are present only in this stage of the insect's life) swims to the surface and climbs into the air on a weed. In a short time the skin swells and splits and the imago emerges.

The Water Scorpion.—This is one of the large water-bugs with the characteristic sucking beak and prehensile front legs used for catching and holding food. Like most of the water-bugs it is partly carnivorous and partly a scavenger. It lives by piercing the tissues of animals and plants and extracting the juices. The "thighs" of the front legs are level with the mouth, and they are provided with grooves into which the sharp-edged shins can be folded much in the way that the blade of a clasp-knife

fits into its handle. Any insect caught between the "blade" and the "handle" is held firmly while the short beak is engaged in sucking up the juices. The beak is formed from the mandibles or first pair of jaws, as in all bugs.

The water scorpion has a dark, ashen-brown, flattened body with two long projections at the tip of the abdomen which interlock closely to form a breathing-tube, the tip of which is protruded above the surface to take in air. The tube encloses the two breathing-holes or spiracles at the tip of the abdomen.

The eggs, which are laid singly, are provided with a circle of hairs which may retain a supply of air for developing them.

As in all bugs the development is direct; there is no pupal or nymphal stage and the larvæ differ little from the adults except in size.

The Harlequin-fly.—This is a harmless, though gnat-like, midge which is often seen dancing on window-panes. It comes to rest with the *front* legs in the air (cf. the true gnat, which comes to rest with the *hind* legs in the air). As in the gnat, the male has bushy antennæ, the female much sparser ones. These flies are seen in summer dancing about in swarms over water, or near to it, but they are not so well known to children as their curious little larvæ, called "blood-worms," which inhabit our water-butts. These "worms," if disturbed, swim with a figure of 8 jerk, straightening the body suddenly and then as quickly twisting it again. The contortions of the body of the blood-worm have given the insect the name of *harlequin*.

The eggs are laid at the edge of the water in little ropes of jelly, about 1 to 1½ in. long, attached at one end to the side of the tub or tank, or to a stone or weed, immediately below the surface. Often these chains of eggs are very numerous. The eggs are dotted along them in a spiral row, curiously twisted, but to the naked eye the pattern is not discernible. The worm-like larvæ are almost colourless when hatched, and they sink to the bottom and make little tubes in the mud. Here they grow rapidly, feeding on decaying substances, and soon attain a bright red colour, due to the same red substance which colours human blood—*hæmoglobin*. This substance has an affinity for oxygen, so that its presence in these animals probably assists them in making use of the limited supply of oxygen dissolved in the stagnant water, for where dead leaves and other substances are decaying they are using up the oxygen present. There is, indeed, another species which lives near the surface, in which the red substance is not present, which supports this explanation of its value.

If a larva is examined with a lens, it will be seen to have a tiny head, with black eyes, and immediately behind it a pair of roundish processes

fringed with small hooks, which probably help it to move about its burrow, while a similar pair on the last segment may help it to hold on. (Cf. the caddis-worm with its little hooks and tubercles). The tube is a much less permanent and elaborate arrangement than the caddis-worm's, and appears to be made by sticking particles of soil together with saliva. On the next to the last segment of the body there are four long, thread-like blood-gills, and on the last segment a bunch of short, thick papillæ which probably help breathing. It breathes entirely under water.

The pupa is very much like that of the gnat, both in appearance and habit, having a very large "head" and curved body. It is distinguishable, however, by the large tuft of white hairs projecting upwards from the thorax, which consists of finely-branched tubes, while on the last segment, in addition to a pair of short processes like those of the gnat pupa, there are two bunches of long bristles, the front ones spreading out stiffly like a comb.

The Pond Skater.—This is a very common, slender-bodied water-bug with long legs adapted for skimming over the surface film of the water. Sometimes the insect submerges and then its hairy body is seen covered with silvery bubbles of air. A long, beak-like pair of jaws forms a sucking-tube, while the front pair of legs is modified to catch and hold insects. The first segment of the thorax is long, so that the first pair of legs lies some distance from the second pair, which carry out the skating movement. The third pair acts as steering gear.

The pond skater feeds on both living and dead insects. Eggs are laid in masses on water-plants. There is direct development, that is, no true larval stage, the young which hatch from the eggs being structurally like their parents, as well as resembling them in habits.

SEASHORE ANIMALS

PLATE 55. CRUSTACEA

The *Crustacea* are a class of the phylum *Arthropoda*—"jointed-feet," to which also the Insects and Spiders belong. The members of the class illustrated on the Plate all belong to the order *Decapoda*, a name which refers to the five pairs (i.e., ten) of thoracic legs of which nearly always one or more pairs ends in pincer-claws. Though crustaceans have a distinct head, thorax and abdomen, some of the thoracic segments are, in nearly all the orders, fused with the head to form a cephalo-thorax, covered on the back with a single horny shell. The animals are covered with an armour of chitin which in many cases is so hardened, except at the joints, by mineral matter, that it becomes a rigid shell or crust. The head bears two pairs of feelers in addition to the jaws; the segments of the thorax and abdomen are provided with appendages which are variously modified as foot-jaws, legs, swimmerets, etc. The animals breathe by gills connected with the blood circulatory system. The compound eyes are borne on short, movable stalks.

As the exo-skeleton consists of dead matter, it cannot grow, and from time to time the creatures cast their skin. During the moulting period they are defenceless and spend the time in seclusion.

The Lobster.—This marine animal is covered by an exo-skeleton of chitin, and has jointed limbs and a segmented body. The head and thorax are fused into one mass, the cephalo-thorax, which is covered by a shield called the *carapace*. Every segment except the last bears a pair of appendages. There are the tail fins and *swimmerets* of the abdominal region; further forward the appendages become *walking-legs*; next come three pairs which combine the characters of legs and jaws and are called *maxillipedes*—"foot-jaws." The primary pair of the maxillipedes ends in pincer-claws (*chelæ*) which are used for seizing food. Then there are the true jaws—two pairs of *maxillæ*, and one pair of biting and crushing *mandibles*. Lastly, in front of the jaws, are two pairs of *antennæ*—"feelers." The paired eyes are borne on stalks which are movably articulated with the head. All the limbs as well as the eye-stalks are covered with horny chitin. Many of these appendages are forked, a distinctive crustacean character.

The gills are situated at the sides of (and outside) the true body-wall at the base of the walking-legs, in chambers formed by the down growth of the sides of the carapace. The gills are branched, compact masses

containing fine blood-vessels covered by a delicate skin, so that an exchange of gases readily takes place between the blood and the surrounding water.

The colour of the common lobster is dark blue to nearly black on the back with a good deal of orange or red on the underside. The lobster shelters in crevices, crawling forth in search of food, and shooting backwards through the water, when alarmed, by powerful strokes of its broad tail-fan. The larger of the two great pincer-claws has the blades armed with blunt knobs for crushing the shells of mussels and the like; the smaller claw has saw-edged blades for holding and tearing the prey. Lobsters readily throw off a limb that is seized by an enemy or injured in fighting. It is replaced by a new limb which only reaches its full size after several moults.

The eggs of the female are carried about attached to the abdominal appendages. The newly hatched larvæ are transparent little creatures that swim at the surface of the sea by means of the swimming-branches with which their legs are provided. After moulting several times, the larva loses the swimming branches; the swimmerets and tail-fan are developed, and the young lobster seeks the bottom to assume the habits of the adult.

The lobster is the object of an important fishery. It is usually captured in lobster-pots, or creels, made of wickerwork, each having a funnel-shaped opening permitting entrance but preventing escape. These traps are baited with pieces of fish, preferably stale, and are sunk on ground frequented by lobsters, the place of each being marked by a buoy.

The Common Edible Crab.—This crab of our coasts is familiar to most people. Like the lobster it is usually found in shallow water among rocks, and young specimens are often met with between tide-marks. It may grow to a weight of as much as twelve pounds.

It is distinguished from the lobster by the small abdomen or "tail," which is folded up under the body. The oval-shaped, flattened body is covered by a carapace. There are five pairs of legs of which the first pair end in pincer-claws. The great width of the shell is largely due to the gill-covers, which stand out from the sides of the body. The result is that the crab finds it best to run sideways. It is essentially a walking and not a swimming animal. The eyes are set on movable stalks and can be withdrawn into sockets in the front of the carapace. The swimmerets, which are developed only in the female, serve for the attachment of the eggs when the crab is, as the fishermen say, "in berry."

The young larva has a characteristic shape and is known as a *zoea*. It is a minute, transparent organism, swimming at the surface of the sea. It has a short, round, helmet-shaped body armed with long spines. The

eyes are large but not set on stalks. The legs are not yet developed and the foot-jaws form swimming paddles. After casting its skin several times as it grows in size, the zoea passes into a stage known as the *megalopa*, in which the body and limbs are more crab-like, but the abdomen is large and not folded up. After a further moult the animal assumes a form similar to that of the adult.

The Common Shrimp.—The word *shrimp* is derived from the Anglo-Saxon word *scrimmon*—"to dry up, wither," and the animal is probably so named from its shrivelled appearance. The common shrimp is found abundantly in shallow water wherever the bottom is sandy. It is slightly flattened and the *rostrum*, or beak, which is an extension of the carapace, is very short. It is of a translucent, greyish colour, speckled with brown and closely resembling the sand on which it lives. The abdomen is sharply bent between the third and fourth segments and has a humped appearance when straightened out. When shrimps are disturbed in a rock pool they settle on the bottom and disappear in a puff of sand which is thrown over the back with "shovels," small scales at the base of the long antennæ.

On the sea-bottom the shrimp moves about on its "walking-legs." It swims forwards slowly by means of its swimmerets, but when alarmed it shoots backwards in the water by lashing its tail forwards and under—as does the lobster.

The eggs are carried by the female attached to some of the swimmerets until they hatch, when they are protected in a brood-pouch made by the bending forward of the abdomen. These *zoea* larvæ are soft, transparent creatures with only the rudiments of appendages except those which are well developed in front of the walking-legs. From time to time they moult and finally assume the form of the adult.

The Common Prawn.—The common edible prawns live in shoals off our rocky sea-coasts. They are pale, greenish-grey in colour, very transparent and marked with red and brown. When full-grown, they are much larger than shrimps, a full-grown one being almost four inches long from the head to the tail.

The life story of the prawn is much like that of the shrimp, from which it can be distinguished by the sabre-shaped, saw-edged beak which projects beyond the carapace. The first and second legs have small, but distinct, pincer-claws. When boiled, prawns turn a bright red; shrimps turn a pinkish-brown.

The Common Hermit Crab.—This member of the genus *Crustacea* is often to be seen in rock pools, scrambling about and carrying with it a whelk shell into which it retreats when alarmed. The abdomen of this

crab is soft so that it protects itself by inserting its body into the empty shell of a whelk or periwinkle, or it may first devour the owner and then occupy its home. The pincer-claws of the hermit crab are of very unequal size, the larger one forming a stopper for the opening of the shell when the creature withdraws into it. The next two pairs of long, slender legs are used for crawling; the last two pairs are provided at the end with pads which grip the inside of the shell and so hold the body in place. The swimmerets, which are conspicuous only in the female, serve for carrying the eggs.

As the hermit crab grows it must, from time to time, change its dwelling. When it finds an empty shell of a suitable size, it carefully explores the shell with its claws, and if the shell proves satisfactory the crab quickly inserts itself into the new home by seizing the shell and swinging its body across—almost vaulting into it. Many hermit crabs live in close association with sea-anemones. Often a hermit crab is found with a sea-anemone attached to its shell. The sea-anemone in some measure protects the hermit crab by its stinging powers and, on the other hand, it shares the crumbs left over from the crab's meals. An association of this kind is called *commensalism*,—"eating at the same table."

The Sand-hopper.—These small members of the *Crustacea* are found in vast numbers about high-water mark on sandy beaches. They are more or less amphibious animals. Usually, on turning over a piece of drifted seaweed, one will see myriads of them leap into the air. As they fall down they lie still for a moment and then bury themselves in the sand. Holes in the sand which appear to have been made by raindrops betray their presence. The body of a sand-hopper is flattened sideways and the abdomen is bent forward under the thorax. The creatures jump by suddenly straightening the bent abdomen. They are often known as *sand-fleas*.

The Heart Urchin.—Heart urchins are small cousins of the common sea urchins, and more distantly related to starfish. They are more or less oval in shape, but broader at one end and flattened slightly on the underside, the mouth or oral side, while the upper, or aboral, side is rounded. The whole surface is covered by a delicate skin. They may reach a length of about $2\frac{1}{2}$ inches.

Like most members of this group (the *Echinoderms*) they have a shell or skeleton made up of numerous small plates closely fitted together. These plates radiate from the oral to the aboral surface. Five rows of plates are perforated by minute pores, through which a double row of delicate, finger-like processes project. These are called tube-feet, since in most *Echinoderms* they are the organs both of locomotion and respiration,

but in the heart urchins they serve as gills for breathing, while walking takes place by means of numerous spines with flattened tips—like little stilts—which cover nearly the whole surface. Certain very short spines are fringed with minute threads of protoplasm called cilia, which are in constant movement. These assist breathing by wafting currents of water over the tube-feet, thus keeping up a continuous supply of oxygen. This is valuable, since the heart urchins spend the greater part of their lives buried in mud or sand, several inches deep. They live chiefly below the level of the low tides.

The mouth is usually pushed towards one end instead of being in the centre of the under surface, as in starfish and the common urchins. It is crescent-shaped and has no jaws, which are unnecessary since the animal lives on tiny living organisms. These are brought to it by specially modified tube-feet lying in the shortest tract. These are long, and expanded at the tip into fringed discs, so that they have a somewhat tree-like form. They are projected above the mud, where they collect small creatures and pass them down to the normal tube-feet in the neighbourhood of the mouth.

The anus is situated at the end farthest from the mouth, just where oral and aboral surfaces meet.

Tube-feet are able to exert suction, which in this case enables them to grasp food and push it into the mouth, but in other *Echinoderms* enables them to cling to rocks. Their action is regulated by a pumping system, consisting of a circular water-canal connected by short channels with the grooves for the tube-feet, and opening to the exterior by a small perforated plate on the aboral surface. Water can be drawn in and the tubes inflated, or withdrawn so that they contract, forming a slight vacuum between the rock and their tips.

Reproduction is by means of eggs spawned into the water. These develop into minute transparent larvæ covered with cilia which enable them to swim, and supported by a curious spiny framework, rather suggesting an easel in shape. They are gradually transformed into the adult form.

PLATE 56. MOLLUSCS

Molluscs are soft-bodied creatures usually protected by shells, though occasionally the shell has been lost ; e.g., octopus, slug. An organ called the shell-gland manufactures the shell, which is hardened by carbonate of lime. Most of the molluscs are water-dwellers. The shell may be in one piece (univalve) or two (bivalve).

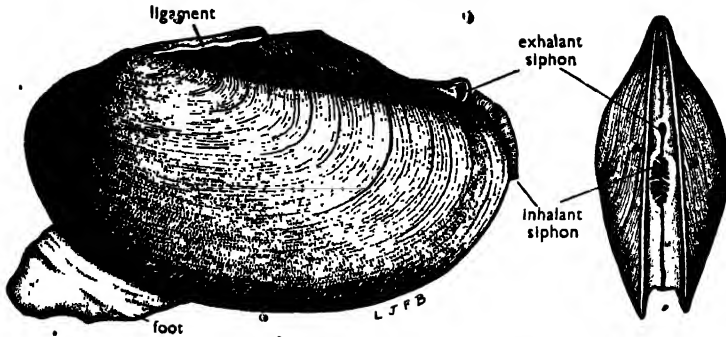


FIG. 34. The freshwater mussel.

There is a wide range of habit and habitation amongst the molluscs, and details of structure and shape, both of shells and body, are found to have close relationship to the kind of life they live.

On the whole, the occupants of univalve shells are more active than those of bivalves, and so it is usual to find they have a well-developed head, with feelers or tentacles, horny jaws and a rasping tongue, that is, a band of tissue provided with many rows of minute teeth. There is generally a well-developed foot, usually with the head attached to its upper side.

In the bivalves, two valves, or halves, are hinged together by one or more strong bands of muscle passing from one to the other. Dull, roughened patches in empty shells usually show the place of attachment of these muscles.

The body is enveloped in a fold of skin which also forms the lining of the shell, called the *mantle*, of which the shell-gland is a part. Bivalves breathe by means of delicate plates of soft tissue, made up of a meshwork which contains much blood. Water is drawn into the mantle cavity at an opening between the two closely-adherent halves of the mantle, the *inhalent*. It is whipped round the cavity by fine motile threads called *cilia*, which are outgrowths from the mantle and gills. This current of water bathes the gill-plates, which are able to extract oxygen from it by means of the blood they contain, at the same time giving up waste carbon dioxide. The water then passes out again by a second opening, the *exhalent*, often placed close to the *inhalent*.

From this current of water minute organisms are also obtained as it passes the mouth. Most bivalves are more or less sedentary; the great development of gills is connected with this habit, which is also accompanied by loss of sense organs, head and jaws.

Most molluscs are provided with a strong, muscular organ of loco-

motion known as the *foot*. This may be used for gliding (snail, limpet); burrowing (cockle); or even jumping (cockle). It is missing in a few forms (oyster), which remain attached to one spot.

Most bivalves live partially or wholly buried in mud or sand, often in deep water. Short or long siphons, bearing the inhalent and exhalent openings at the free end, then project above the surface of the mud into the water. Where the animal (cockle) lives between tides, these are withdrawn when the water recedes, the shell being closed and completely buried.

The Gréat Scallop or Clam.—This well-known bivalve is often seen in the fishmonger's shop, where the bright orange colouring of the foot makes it a conspicuous object. The fluted shells are prettily coloured in red and orange. One valve, deeper than the other, contains the body, while the flatter is uppermost and forms a lid. Young scallops swim freely by clapping the shells together. The fringed edge of the mantle bears a number of minute, black pigment spots, or eyes, which are apparently sensitive to light. The fringe is sensitive to contact.

The Common Whelk.—This well-known mollusc is plentifully distributed round our coasts. Its thick, spirally built shell protects it from the rough seas and from enemies. The whorls are crossed by curved broad ribs which are traversed by the spiral lines. The "buckie" as it is often called, not only feeds upon decaying matter but eats living oysters, mussels and other "shellfish." It bores a hole through the shell by means of its sharp-toothed radula, which is carried inside a protrusile proboscis, and sucks out the soft body of the animal. At the "tail" end of the foot is a horny plate (*operculum*) with which the opening is tightly closed when the whelk withdraws into its shell.

On the left side of the margin of the shell is a notch where the edge of the mantle is drawn out into a long siphon through which fresh supplies of water are drawn in to the respiratory organs.

Eggs are laid in horny capsules clustered together in masses. Each capsule contains perhaps five hundred eggs, but only a few of the eggs develop into whelks. The first few larvæ, perhaps only half-a-dozen, that hatch out from a capsule feed on the unhatched eggs and upon other larvæ that develop later. The sponge-like, straw-coloured masses of empty egg-cases are common objects thrown up by the tides.

The Dog Whelk.—This mollusc can be found at low water on groins and breakwaters or crawling on sand. It feeds on other molluscs by drilling a hole through the shell to get at the contents. Periwinkle, limpet and other shells may often be found with a neat, round hole in the side made by the dog whelk. The netted species shown on the Plate

has transverse ribs on the whorls, connected by finer ridges which divide the whole surface into small squares. The colour is very variable—cream, yellowish, greyish or brown, sometimes banded with brighter colours. In texture the shell is thick and rather rough. The foot is broad and yellow, speckled with black, and having a horn-like process on each side of its front end and two small pointed "tails" at the back end. It has eyes, tentacles and a long siphon which it carries extended. The egg-capsules are flattened oval pouches, often attached by a short foot-stalk to the fronds of the grass-wrack.

The Razor Shell.—This bivalve is an inhabitant of sand or mud under water. The shell is adapted for burrowing, as is the curious elongated foot which is capable of great stretching. The razor shell is uncovered only at very low tides. It makes a deep tunnel and moves up and down rapidly by a series of jerks, caused by rapid elongation and then contraction of the foot. The tip of the foot can be hooked to grip the ground and puffed out so that it is tightly wedged in the burrow. When covered with water two short siphons open on the surface of the sand.

The Periwinkle.—The dark, slate-blue or greenish shells of periwinkles are well known. A periwinkle feeds on seaweeds, for the rasping of which it is provided with a very long radula. It has a pair of tentacles and eyes on little tubercles at their base. Like most molluscs having spiral univalve shells, a periwinkle breathes by means of small tufted gills inside the shell, and provided that these can be kept damp, it can remain for hours out of water. A periwinkle closes the mouth of the shell by means of the operculum attached to the foot, which fits exactly into the opening when the foot is withdrawn.

The Common Limpet.—The hard, dull, greenish or brownish tent-like shell clinging tightly to rocks and groins, is well known to every one. The common limpet becomes active only at night, when it raises the shell slightly, projects its disc-like foot all round, and moves off to its feeding-ground. At the front end is a broad, short head, a pair of short tentacles and a mouth, provided with a long, ribbon-like rasping organ. With this it bites off seaweed against its horny jaw, and rubbing it against the rows of hooked teeth, breaks it into small fragments which can be swallowed. Before daybreak the limpet returns to the same resting-place as before and settles down on the rock, fitting into its former situation so exactly that in the course of time a shallow pit is worn, the edge of the shell coinciding with the rim. By clinging so closely to the rocks when they are uncovered at low tide, water is shut inside the shell and the gills are kept moist until the return of the tide.

It is noteworthy that a number of molluscs seem to have a very good sense of direction. The homing instinct is marked in the garden snail, which sets off to feed at night, and returns by the same track at day-break.

The Top Shell.—This common mollusc has a broad cone-shaped spiral, the shape of a top. The colour is variable; sometimes it is very bright. Top shells are found at low water feeding like periwinkles on seaweeds. They are very much like snails, having a head, tentacles and a broad foot, but in addition, wide edges of the mantle project as lappets at the sides. The most common are coloured in bands of chocolate and white, purple and white, or slaty-blue and reddish-brown, rather like the banded snails of the hedges.

The Common Cockle.—This edible "shellfish" burrows in sandy shores, to a depth of 18 in. or more if disturbed, but when the tide is high it lies just beneath the surface of the sand, with two very short siphons protruding. A broad, curved foot enables it to burrow and to leap along the surface.

All the burrowing molluscs seem to be aware of the returning tide. The burrowing habit serves both to protect them from the force of the waves, which might batter them to pieces (as the empty shells are broken), and to prevent their being washed out to sea.

The Common Mussel.—This is one of the most useful of the molluscs to mankind, for in addition to its wide use as food, it is of great value as a bait in long-line fishing. Mussels attach themselves in myriads to rocks, timber and masonry. This habit of crowding together is probably closely associated with the contracted, wedge-like form of the shell. Although the mussel is always found hung up by tough threads which form the *byssus*, it can separate itself from these threads and move about on its long, narrow, fleshy foot. Each thread of the byssus is secreted by a gland in a groove of the foot, and issues from between the valves. The fine viscid threads harden in the water. The dog whelk is an inveterate enemy of the mussel, through the shell of which it bores and afterwards sucks out the flesh by means of its proboscis.

The Common Oyster.—This bivalve is a popular article of food. The valves are not equal in size or form; the lower (left) is larger and convex, and the upper (right) is flat or slightly concave. At an early stage in its growth the left shell becomes cemented to a stone, an older shell, or some other object at the bottom of the water. The oyster has, therefore, no need of a foot, which is rudimentary. It is entirely dependent for its food on the nutriment brought by the currents of water. The mantle has a double margin with a fine fringe, and on it are tiny pigmented

masses sensitive to light. The solitary pair of muscles for closing the valves is placed nearly in the centre of the body.

Individual oysters are normally at one time either male or female, but they change from male to female and back again many times during life. Some are hermaphrodite; i.e., they combine the sexes. The female-functioning individual spawns its eggs from the body, but retains them in the shell where they develop into tiny motile bivalve larvæ before they leave the parent. An individual three to four years old may spawn half a million eggs, while one seven to eight years old may spawn $1\frac{1}{2}$ millions or more in a season.

At the age of about ten days, the larva leaves the parent to swim freely in the sea by means of cilia. After about a week or ten days of feeding and growing, it settles down to a permanent sedentary life. It attaches itself by cementing the left valve of the shell to the object, loses its swimming organs, and quickly begins to develop rudimentary adult organs, being then known as a *spat*.

Oysters grow slowly and they may take from six to seven years to become full grown. They have many enemies. The whelk bores into the shell and sucks out the contents; the starfish pulls the valves open; the octopus with its parrot-like beak, and the skate with its powerful teeth, add to the destruction. There is, also, an orange parasitic sponge (*Cliona*) that bores a network of tunnels ramifying throughout the shell, rendering it rotten, and compelling the oyster constantly to deposit new layers of shelly matter to repair the damage.

Oysters breed during the summer and then they are considered "out of season," that is from May to August.

PLATE 57. MISCELLANEOUS SEA-CREATURES

Barnacles.—Barnacles are *Crustacea* which show little resemblance to other members of the Class, such as lobsters and crabs. Ship barnacles cluster on logs of floating driftwood and are the chief cause of the fouling of ships' bottoms. The rock barnacles or acorn shells cover the rocks round our shores just below high-water mark.

When the larvæ of barnacles hatch from the eggs, they swim for a time at the surface of the sea and at this stage show their resemblance to the larvæ of other members of the *Crustacea*. The time comes when the larva is ready to settle down for life. It stands on its head and fastens itself down with a sticky substance which hardens in water. The head of the goose barnacle grows a long stalk which bears at the free end a shell made up of five plates hinged together. From a slit on one edge of the

shell can be stuck out six pairs of long curled feet, each having two branches with stiff bristles. These feet spread out and sweep the water like a fishing-net for the capture of floating prey; they are then withdrawn into the shell. A barnacle has been described as "a crustacean fixed by its head and kicking its food into its mouth with its legs."

The acorn barnacles have no stalk and the conical shell is cemented directly to the rock. At the top of the shell is an opening closed by two pairs of valves between which the feet are protruded.

The Common Jelly-fish.—There are many kinds of jelly-fish and their home is the surface of the sea, where they float lazily, or move along by closing and opening their umbrella-shaped body. The common jelly-fish is of a milky-blue colour varying in size from two inches to a foot in diameter. There are round the margin of the body eight notches and a fringe of small tentacles.

The jelly-fish has no head, but in the middle of the underside is a mouth from which a short tube enters the stomach. Undigested food is passed out of the stomach through the mouth. Jelly-fish may be thought of as "mouth-and-stomach" animals.

The body, though of living substance, is composed almost entirely of water, contained by a skin so fine and soft, that when a jelly-fish is thrown up on the shore it dissolves in the sun, leaving behind only a stain which for a short time shows where it was. Jelly-fish are not really "fish" and they do not breathe by gills. Air dissolved in the water passes through their delicate skin.

Jelly-fish are mostly flesh-eaters and the way in which they capture their prey is interesting. On the underside, from the corners of the mouth, are produced four fleshy tentacles, which are armed with stinging thread-cells. As a jelly-fish moves through the water, the tentacles seize the prey and the stinging-cells shoot into it an immense number of minute, poisonous threads which paralyse it. The tentacles then carry the victim to the mouth and it is swallowed. Inside the digestive cavity there are many gastric filaments which are also richly beset with stinging-cells.

On the underside of a jelly-fish may be seen four brightly-coloured, horseshoe-shaped or circular reproductive organs which contain either the egg cells or the sperms.

The eggs develop in the jelly-fish and the larvæ make their way out through the mouth by means of cilia. The tiny larvæ swim about freely for a short time and then settle on the sea-bottom, or become attached to some object. The lower end of a larva becomes slender and a mouth appears at the upper end, surrounded by tentacles. When this embryo jelly-fish has reached a height of about $\frac{1}{2}$ in., ridges appear round the body

at regular intervals. Soon the ridges develop into grooves, which become deeper and deeper until the body looks like a pile of tiny saucers supported on a short stalk. Gradually the edges of the " saucers " become indented and, beginning at the top, each " saucer " in turn becomes detached, turns upside-down and swims away as a small jelly-fish, which will gradually grow into a full-sized one.

The Common Starfish.—This familiar marine animal belongs to the phylum *Echinoderma*—" hedgehog-skinned." The animal consists of a central body and five arms. The upper surface is covered with a leathery skin in which are little plates of carbonate of lime, many bearing spines, and some, pincer-like bodies mounted on short stalks. These pincer-like bodies, known as *pedicellariæ*, are very tiny, but under the lens they may be seen snapping together and opening again. Some naturalists tell us that these pincer-like bodies are used both for catching hold of small food particles and as weapons of defence. Others think that their function is to keep the body clear of foreign matter that might accumulate between the spines.

On the under surface is the mouth surrounded by a number of spines and leading into a large sac-like stomach. A groove runs from the end of each arm to the mouth, and on either side of the groove is a series of transparent tubular " feet " arranged in pairs. These tubular feet terminate in sucker-like discs which take a firm hold of any solid object in the neighbourhood. By means of these " tube-feet," combined with the muscular action of the arms, a starfish moves from place to place.

The mechanism by which this movement takes place is hydraulic. The tube-feet are expanded into tiny muscular, hollow bulbs, each connected by a short tube to a canal which extends along each arm and is in turn connected with a hollow ring round the mouth. The ring communicates with the upper surface by a canal ending in a sieve-like plate. Water passes through this plate and fills the whole system of tubes and the bulbs attached to the tube-feet. The walls of the bulbs can be contracted at will and they force the water into the tube-feet, causing them to expand. By muscular action of the tube-feet the water is driven back into the bulbs and the feet are consequently contracted. By this alternate expansion and contraction a starfish is able to move along.

At the end of each arm there is a single tube-foot having no power of contraction and it is used as a feeler. Above each feeler is a small, red eye-spot.

The female drops eggs into the sea where they are fertilised and develop into free-swimming larvæ which become small starfishes in about six weeks.

Starfish live at the sea-bottom, crawling over the rocks and sand in search of food which consists of mussels, oysters, scallops and other molluscs. To get at the contents of a mussel, a starfish crawls over it and with its powerful tube-feet and the muscular strength of its arms pulls the shell open. It then protrudes its stomach through its own mouth and uses it as a pump to suck out the mussel, which is thus partially digested by the starfish outside its own body.

The Cuttle-fish.—This strange dweller of the sea is one of the molluscs, having a soft, naked body which is due to the fact that the mantle has grown round and over the remnant of the original external shell and covered it in, so that the shell has become internal and largely degenerate. This white shell known as "cuttle-bone" is used for polishing wood and is of value for feeding cage-birds.

The general shape of the cuttle-fish may be compared with that of a rubber hot-water bottle. The head and body are fused to form a single mass, hence the cuttle-fish belongs to the "head-footed" class of molluscs.

The body is ornamented with zebra-like stripes and edged with folds of flesh called "fins," which are used for leisurely swimming. Embedded in the skin are many colour cells of a specialised form which enable the animal to change its colour at will.

The head bears two prominent eyes and a horny mouth encircled with five pairs of fleshy tentacles. Four of these pairs are provided with many powerful suckers, small cup-like organs, which adhere to the prey that comes within their grasp. One pair of arms, longer than the rest, has suckers only at the tip, and this pair, which can be withdrawn into pouches, is used for capturing prey.

On the ventral side there is between the mantle and the body an air-sac in which are gills, and protruding from it a muscular funnel. Water is drawn in through a slit-like opening and is discharged through the funnel. The discharged water can be blackened by an inky fluid called *sepia*, which is given out by a special gland and stored in an "ink-bag" connected with the funnel. The *sepia* was once used as a writing medium and is still manufactured into the *sepia* paint used by artists and draughtsmen and called Indian ink.

A cuttle-fish sometimes swims by making rhythmic movements with the "fins," but usually the animal jerks itself along backwards by expelling jets of water from its funnel, at the same time alternately opening and closing its arms to drive a current of water forwards. When alarmed it produces its inky cloud which is of much value in hiding the creature from its enemies.

The cuttle-fish lurks hidden at the sea-bottom to wait for its prey.

Perhaps it marks down a prawn poised on a projecting ledge of a rock. This it stalks with great caution and when it is within striking distance the cuttle-fish shoots out its tentacles and drags the prawn into the circle of shorter arms, by which the prey is closely held while it is dismembered by the "beak" or horny jaws of its captor.

Cuttle-fish are often found in shallow water near the coast, and they usually come to inshore-water to deposit their eggs which are dark, grape-like objects laid in clusters on the stems of seaweeds. They are known to fishermen as "sea-grapes."

The Sea-Anemone.—This is the name given to numerous, almost invariably solitary, and often large and beautifully coloured, polyps which are found fixed on the rocks round our coasts between high and low-tide marks. Their form, bright and varied colours, and numerous tentacles surrounding the mouth, often give them a superficial resemblance to a flower.

The bag-like body broadens slightly at the base and this end is attached to a rock. There is no head and no eyes, but the narrow, upper end has a flat disc with a slit-like mouth which leads by a tube into the body-cavity, where it extends to form a gullet. Round the margin of the disc is a fringe of tentacles armed with stinging-cells which serve to protect the animals from enemies and also to paralyse their prey, consisting of worms, shrimps, and many other small creatures.

A sea-anemone obtains dissolved air through its delicate skin; it can, however, live exposed to the air between tides. The body-cavity is then filled with water, the tentacles are drawn in and the creature huddles close to the rock. At such times it looks like a blob of jelly and is by no means beautiful.

The fertilised eggs usually develop to some extent inside the parent, becoming hollow, ciliated larvæ which escape from the mouth of the parent and then swim about for a while before settling down to grow into adults. There is no intermediate stage as is found among the jelly-fish.

FISH

Fish, the most ancient of vertebrate animals, originated in the sea and, achieving greatly diversified forms, have adapted themselves to every type of water habitat. Some fish swim about in the upper reaches of the oceans, others live in the depths ; some like clear water or sandy bottoms, while others are at home in mud ; some prefer sluggish, stagnant waters and others swiftly-flowing streams. There are fishes which swim hundreds, even thousands of miles in pursuit of their food, which is borne on ocean currents, while others spend their whole life in the confines of one pond. Some can live in brackish water, while others, notably eels and salmon, pass a certain stage of their lives in the fresh water of inland rivers or lakes, and another stage in the salt waters of the ocean.

The shape of a fish usually gives some indication of its habits. The long, cylindrical, "streamlined" body, pointed at either end, is made for speed and to offer the minimum of resistance ; the powerful, muscular tail is assisted in its stroke by the spreading fin ; the paired fins and those on the upper and lower surface aid in direction, balance, and braking. These points are beautifully exemplified in the mackerel and the herring, shoals, or schools of which cover many miles in a few hours.

The most important groups of existing fishes are the Cartilaginous Fishes, the Bony Fishes, and the Lung Fishes. By far the largest number of fish belongs to the middle group, but the others have some features of much interest.

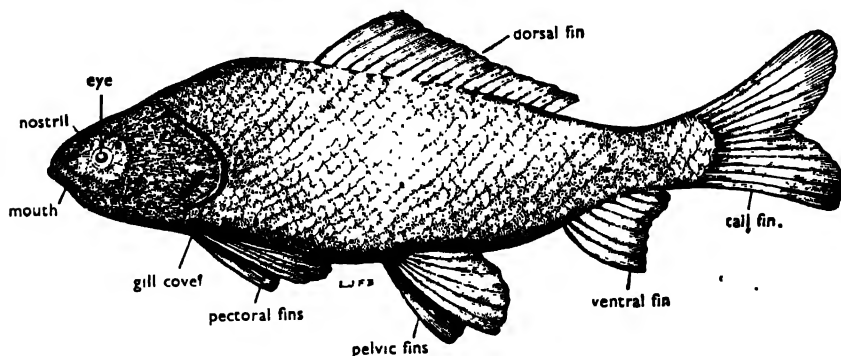


FIG. 35. Carp.

The Cartilaginous Fishes.—As the name implies, a fish of this group has a skeleton composed of cartilage or gristle, which is never ossified. The vertebral column and skull are, therefore, tough and elastic, but not hard, while the fins are flaps stiffened with cartilage but not supported by bony rays. The fish breathe by means of gills, which lie in pairs of gill-pouches, with visible external slits since there is no bony plate to cover them. Further characteristics will be given when we describe the dogfish, which belongs to this sub-class. It also includes the sharks and skates or rays.

The Bony Fishes.—The body of one of these fish is supported by a vertebral column consisting of many bi-concave bony segments, provided with spines. In addition there are thin, spiky ribs. This is the endoskeleton or internal skeleton. In addition there is an external skeleton or exo-skeleton, consisting of membrane bones or skin-formations. These include the jointed rays of bone which support the delicate substance of the fins, and the bony plates on the sides of the head which protect the gills. These gill-covers are called *opercula* (sing. *operculum*).

The fins in bony fishes comprise two pairs and several unpaired. The foremost paired fins are called *pectorals* and they correspond to the front limbs of the higher vertebrates. Rudiments of a pectoral girdle can be distinguished, but as the water counter-balances the weight of the body, the limbs do not bear the strain of supporting it, as in land vertebrates, hence no great development has become necessary. The hinder pair of fins are called *pelvics* and they correspond to hind legs, but, again, do not bear any weight. In some fishes, however, the fins are used at times for scrambling about, when they really serve as short legs; e.g., the climbing perch of the shores of the Indian Ocean.

The unpaired fins consist of the *caudal* or tail fin, one or more *dorsal* fins in the middle of the back, and a *ventral* or *anal* fin in the middle line close to the vent or anus.

Respiration in all fishes is carried out by means of pouches of the thin, delicate lining of the pharynx, the region of the alimentary canal just behind the throat. From these pouches grow hollow fringes called gills, which are amply supplied with blood-vessels. The pouches open internally into the pharynx, and externally through the body wall by means of paired slits—usually five pairs—called gill-slits. A supporting framework to the gill-pouches is provided by bony arches. From the foremost of these arches the jaws are developed.

In order to obtain the necessary supply of oxygen a fish gulps in water, which contains a small proportion in solution. The mouth closes and the water is forced over the gills, which, by means of their blood

supply, can extract the oxygen at the same time releasing carbon dioxide, one of the body's chief waste products. The water then passes out by the gill-slits and under the hinder edge of the operculum, which opens and shuts rhythmically with the movements of the mouth.

The body of a typical bony fish is covered by small overlapping scales of a horny substance unaffected by water. These vary greatly in size and pattern in different kinds of fish. They are concentrically marked with lines of growth which afford to the expert evidence of the age of the fish.

The Lung Fishes.—These fishes, few in number to-day, are of very ancient lineage. Their distribution is now confined to certain Australian, South African and South American rivers—a peculiar continental limitation which they share with certain ancient types of birds and mammals such as ostriches and kangaroos.

The special interest of the Lung Fishes is that, in addition to being provided with gills, they do indeed breathe by lungs, which apparently come into action under certain trying conditions when, in a hot, dry climate, the river bed dries up and becomes a tract of mud. The lungs are outgrowths of the pharynx, similar in origin to the swim-bladder by which many fishes are able to adjust the internal pressure of the body to changes in the external pressure of the water, as they sink or rise to different levels. It is supposed that in some such way the higher vertebrates came to change their method of breathing, discarding the use of gills and beginning to rely on new organs which could inhale atmospheric air, when the transition from a water existence to life on land was taking place. In support of this view it may be mentioned that in the embryonic stages of all land vertebrates, man included, a fleeting glimpse of the older method of breathing may be seen in the opening of paired gill-slits, which close again and vanish—the ears, however, indicate where one pair was situated. Tadpoles of frogs and newts live through this transition again in their own lifetime, beginning as gill-breathers and passing on to become lung-breathers, with a short period in which both are operative together.

PLATE 58. FRESH-WATER FISH

The Minnow.—Length, up to 4 in. Minnows are found in the summer, from about April, in running, shallow streams, where they assemble in shoals near the surface or amongst weeds. In the winter they hide in mud or weeds in ditches near the river, where they are safer from being washed away by floods, down weirs and waterfalls. After

spawning they are in their best form. The body is then silvery-white underneath, the sides "inclining to a greenish or sky-colour," and dappled or striped with black; the back is blackish.

The elongated, shapely body is apt for swimming, darting and turning quickly; the pectoral, ventral and caudal fins are spaced equally apart; the dorsal fin starts behind the ventral and ends in a line with the beginning of the anal. The size of the minnow is enough to distinguish it from adult members of the Family to which it belongs. The Family includes roach and chub, dace and rudd.

The minnow also differs from all these cousins in having an incomplete lateral line. Along each side of the body is a line which apparently consists of large pores. As this line is a constant feature in fishes, it is presumably important in some way, but experiment and observation have hitherto failed to determine its use with certainty. The minnow feeds on water-weeds, worms and other animals, including dead bodies of its own species. It is, according to Izaak Walton, a favourite natural food of trout and a good bait for them.

The Stickleback.—Length about $3\frac{1}{2}$ in. This is the "tiddler" of the pin and jam-jar fisherman. The name stickleback has reference to the sharp spines which decorate the middle line of the back. These vary in number in different species, the three-spined being perhaps the commonest. The body is thick in the middle, compressed from side to side, silvery in colour, with green and gold reflections. In the breeding-season the male glows like a jewel with bright rose colour underneath. Species of sticklebacks are found both in fresh-water and in the sea, and the common three-spined stickleback, though typically a fresh-water fish, migrates in shoals to the sea at times, and is apparently equally comfortable in fresh or salt water.

Sticklebacks are notorious fighters. The male makes a small barrel-shaped nest of water-weeds, into which he invites several females, one at a time, to spawn their eggs, which he fertilises at the same time. He then incubates the eggs and guards the young fish, attacking all comers and shepherding the young back into the nest if they try to escape, until they are sufficiently mature to set out for themselves.

The Perch.—Length, up to 2 ft. The perch is best known as a smallish fish, under a foot in length, perhaps 6–7 in. being the commonest. It is an inhabitant of sluggish streams and ponds, usually keeping to holes or close to the bank, where it searches for worms, insects and small crustaceans, such as fresh-water shrimps. It breeds from its third year onwards, and at the breeding-season seeks shallow water with a good current. Many fishes which inhabit deep water migrate to sandy or

gravelly shallows to deposit their eggs. The perch is a stout, thickset fish, olive-green with dark, broad stripes above and yellowish below. It becomes much brighter, flushed with red on the fins, at the breeding-time. It has two dorsal fins, the first rounded, with many strong spines, the second almost rectangular. All the unpaired fins have one or more spines and the rays are strongly developed. The eyes are deep yellow.

The Trout.—Length, up to 2 ft. The graceful elegance of trout as they glide upstream in clear, shallow streams has made them an object of admiration, while their delicacy of flavour makes them the most esteemed of all fresh-water fish as food. In colour the trout is brownish above with dark spots and silvery below; the lateral line is marked by red spots ringed with white. The colour varies a great deal with the depth of water, being darkest in deep water—a form of camouflage which is very effective in affording protection—as anyone who has watched for trout will appreciate. Trout usually pay an annual visit to the sea, returning looking brighter and deeper in colour.

All species of trout are closely related to salmon, sea-trout or salmon-trout, and chars, all of which belong to the same genus *Salmo*.

Pike.—Length, up to 4 ft. There is something sinister about the appearance of this fish, with its cold, staring eyes, waiting attitude and enormous, strong jaws that can close like a steel trap on its victim—another fish, a water vole, perhaps the leg of a duck, or a moorhen which has approached unwarily. Many extraordinary stories are told of pike attacking swimming dogs, fighting with otters for their prey, and swallowing voraciously iron chains and other curious objects without waiting to examine them. As the pike is both bold and wary, it is regarded by skilled fishermen as a worthy antagonist. It is their glory to have captured a large pike or jack, and the size of the fish and intensity of the struggle are apt to increase with each telling.

The pike is very distinctive in form, having a long snout with the lower jaw longer than the upper; strong teeth in the sides of the jaw and smaller ones in front and on the palate; a flattened head and straight back, forming almost a straight line with the head. The body is long and narrow, the dorsal fin placed far back and rounded, and the paired fins spaced far apart. It is greenish-grey with yellowish blotches and patches; the scales are very small. Generally, a single pike will dominate a particular part of a slow, weedy river or pond, gradually clearing its preserve of other fish, so that fishermen usually know that in a particular shadowed pool by a bridge or in a back-water, one old pike has its home. The pike is to the river fish what a shark is in the sea, or an alligator in a tropical river.

PLATE 59. SEA FISH—I

The Red Gurnard.—Length, 9–12 in. This fish, like other species of gurnard, is a ground-dweller, which feeds on fish and crustaceans, such as small crabs and prawns. It seems typical of ground, shore and rock fish (which do not swim great distances) to have relatively large heads and small bodies. The head of the red gurnard is unusually large and proportionately broad. The head slopes down sharply in front from a prominent forehead; the eyes are large, as in many deep-sea dwellers; and the appearance is made still more remarkable by the prominent crest of the first dorsal fin and the long, stiff spines under the chin. The pectoral fins are large, situated immediately behind the operculum, while the long, narrow pelvics are close behind them. There is a second dorsal fin, forming a short continuous crest almost to the tail fin. All the fins have prominent rays, and the sides of the laterally-compressed body have short furrows near the dorsal surface. The bright rose colour adds a final striking touch to the peculiar appearance of this fish. Incidentally, the spines and bony prominences make it a difficult fish to prepare satisfactorily for the table although it is at most times plentiful.

The Red Mullet.—Length, up to 17 in. This fish is sometimes known as the striped mullet. It is not, indeed, very red, and is considered to be a variety of the much rarer true red mullet, which is a plain red all over. Both fish feed on the ground and at the surface, for the most part keeping out to sea, but coming inshore in July, the striped mullet appearing with the mackerel shoals in the summer.

This mullet is pale pink banded about the lateral line with yellowish stripes. The scales are noticeably large, covering not only the body, but forehead, nape, cheeks and operculum. Though it may reach the same size as the rarer red one, this mullet is usually smaller. Both species have two longish barbels projecting under the chin, probably serving as feelers.

The Common Sole.—Length, up to 18 in. Most examples are not more than 10–12 in. Here is a true ground-dweller, which after a short sportive childhood of free swimming, settles down sedately to days of dozing, almost completely buried in a sandy or gravelly bed, and nights of hunting for worms and small crustaceans which serve it as food. Any one who has visited the Aquarium at the Zoo must have seen these fish, lying with the snout and nostrils protruding from the sand, or very occasionally bestirring themselves, causing a small upheaval as they emerge. They flap along a few inches above their bed with surprisingly graceful undulations, then settle again and disappear with two or three

swift movements. The soles and other flat-fish are very interesting examples of extreme structural adaptation to a peculiar habit of life, within the lifetime of each individual. In their early days there is nothing to distinguish them particularly from other normal fish. But a profound change takes place, gradually, as they assume the ground-dwelling habit. Look closely at the picture and note the position of the mouth—a horizontal cut at the anterior end. This gives the clue to the change. One might assume that the picture shows the *back* of the fish. This is not so. We see the *right side*. Note the gill-plate and *one* small pectoral fin just behind it. Note, too, the plane of the tail fin. The continuous dorsal and anal fins mark the middle line of the back and belly respectively. In other words, the fish settles down to lie on its *left side*, and when it swims, it progresses left side downwards. The left side, never exposed to the light, develops no colour and is white. The upper or right side becomes darkly pigmented, brown with black blotches, resembling the bed of the sea as seen by any fish swimming above it, and so providing a remarkable example of protective resemblance or, as it is now the fashion to say, camouflage.

Note that *both eyes* are on the right side of the body. In the young fish the position of the eyes is normal, one on each side of the head, but by an unequal growth of the skull, the left eye is gradually rotated over to the right side. On close examination it will be seen that there is a slight irregularity, or lack of symmetry in the position of the eyes, the only trace in the adult of anything abnormal having taken place.

The Herring.—Length, 10–13 in. If it were not so common, we should probably be struck by the great beauty of the herring, even as it lies on the fishmonger's slab. Under natural conditions in the sea, the lithe bodies, silvery beneath and steely-grey above, flashing with rainbow colours as the shoal swims near the surface and catches the light, have a fascinating beauty. Slender, tapering like a torpedo, flattened laterally, and provided with a large, forked tail fin, a clean cut dorsal like a small sail, and serviceable paired fins, the herring is like a small, efficient engine of polished steel hurling itself by its own power through the water. No projections of spines or clumsy outgrowths impede its movements. The eyes lie flat, wide open and, of course, with no lids, as in all fish; the operculum lies flat to the head. Here is structural efficiency which any ship designer might envy, and powers of speed and endurance which, in proportion to its size, must exceed those of any speed-boat. Herrings are most important food fish and are chiefly caught coming to comparatively shallow waters to spawn. The eggs are attached to stones. The young fish are caught and sold as whitebait.

The Mackerel.—Length, 12 in. Really large specimens reach 16 in. Like the herring, this is a gregarious fish, ranging widely in following the fry of other fish, on which it chiefly feeds. It pursues these into shallow seas, feeding on the surface. Note the similar elegance and clean lines. The colouring is dark green shot with blue, iridescent and light silver beneath, with dark wavy stripes on the sides and one dark stripe below the lateral line. Behind the eye is a yellow patch. The body narrows almost to a point close to the attachment of the large forked tail. The hinder part of the dorsal fin is broken up into finlets.

The Pipe-Fish.—Length, 13 in. There are several different pipe-fish, chiefly deep-water fish. The body is narrow and cylindrical with a number of longitudinal ridges, continuing on to the elongated, narrow tail. The whole body and tail are covered with bony plates arranged in rings, the fins are small, the tail fin is short and straight, while the dorsal fin forms a small crest extending over ten or fourteen rings about the middle of its length. The most peculiar characteristic, however, is the tube or pipe projecting in front, formed by an exaggerated elongation of the jaws, which suggests a duck's beak and is obviously a sucking-organ.

The pipe-fish mostly uses the dorsal fin in swimming, in addition to making wriggling movements with its whole body. It is a defenceless fish for it cannot bite and it depends largely on its colouring for protection. Pipe-fish live near the shore where their colouring and swaying movements make them appear much like the fronds of the seaweeds.

The male fish takes care of the eggs and of the fry, carrying them about in a brood pouch placed on the underside of the body.

The Armed Bullhead.—Length, up to 6 in. This small fish, also known as the *pogge*, is a ground-feeder, frequenting river-mouths. Like many fish with this habit, it has a disproportionately massive head and chest region, narrowing down sharply to the hinder end. In its grovelling movements it obviously depends largely on the pectoral fins, for these are very extensive and rounded like paddles. It has two dorsal fins, the first rounded, with five spines, and the second with five or six rays. The ventral, also, has a spine. Under the chin are many short barbels, or barbules. The armature, which gives the fish its name and distinctive character, consists of ridges of bony plates, dividing the body longitudinally into eight flat sections. The colouring is probably protective—as, indeed, is that of perhaps the majority of fish. It is pinkish or yellowish-grey, spotted and banded vertically. The pectorals also show broad, shadowy bands, which suggest ripples and break up the outline of the body, so that, in the water, the shape does not catch the eye.

The Eel.—Length, male, 20 in. ; female, 3 ft. The measurements given for all fishes figured on these Plates are extremes, met with in old animals, and in most cases smaller specimens are more common. The shape of the body of the eel suggests the wriggling, twisting movements which we associate with this fish ; it is long, narrow, of uniform thickness, and cylindrical. The head is no broader than the rest of the body and offers no resistance to the water. The paired fins play no part in actual locomotion ; the pectorals are very small and the pelvics absent. The dorsal and ventral fin form one continuous ridge—the condition which is supposed to have existed in primitive fishes, before fins were differentiated for various purposes. In the eels, however, it is not a primitive condition, but a modification for their method of movement. The tail fin has been lost and the dorsal and ventral have become elongated.

Scales are either very small and deeply embedded in the skin, or completely absent. In colour the eel is deep olive-green above, and white or yellowish below. The skin secretes a copious, thick slime.

Eels breed in the sea, but feed in fresh-water, in rivers and ponds. After two or three years of this life they descend to the sea to breed. The amazing fact has been discovered that all the eels of Europe and America have one breeding-ground, far out in the Atlantic where the drop from the coastal shelf to the abysmal depths begins. In the autumn, especially after storms, a great urgency seizes all the mature eels, and they swarm down the rivers, pour out of the estuaries and, plunging deep down, swim at the bottom, thousands of them together, until finally they reach their destination. They make the return journey after having gone over the ground only once, in the reverse direction, when they were minute youngsters like bits of wire. How it is accomplished and how they know their direction is one of the mysteries of life.

Spawning takes place, and from the eggs hatch larvæ so unlike the parents that for a long time they were thought to be entirely different creatures. These larvæ look somewhat like thin, transparent strips of glass. They are flattened from side to side, and colourless, with minute heads. These change gradually, appearing to shrink and thicken, so that they look like tiny threads or bits of wire. In this condition they ascend the rivers, gradually growing all the time. From the river-mouths they reach small streams and ditches—where specimens 5–6 in. long are numerous in early summer. Many of them leave the water and wriggle through wet grass, until they find a pond or ditch which is suitable for their life, having clear water but a muddy bottom.

PLATE 60. SEA FISH—II

The Cod.—Length, up to 5 ft. The cod and the herring are our two most important food fish. Although these fish are constantly hunted for food, spawning is on such a large scale that it is probable that the supplies remain almost constant. We associate cod particularly with the North Sea, Iceland and Newfoundland fisheries. They travel together in large shoals. In general shape cod resemble herring or mackerel, though they are much larger and proportionately rather heavier in build. The colour is yellowish, brownish or olive-grey above and lighter underneath; the scales are small. The pelvic fins are small and directly below the pectorals, but the dorsal and ventrals are strongly developed and extensive. There are three large lobes to the dorsal fin and there are two ventrals. The tail fin is also large, but the hinder edge is straight, not forked. The lateral line is white and distinct. The main diet of cod is small fish, shellfish and crustaceans; the fish feed near the ground.

The John Dory.—Length, under 24 in. This fantastic fish has habits in keeping with its strange appearance, for it swims, as one writer states, not upright, but “with a list to starboard.” Its large mouth can be protruded to form a tube. Moreover, “it grunts, squeaks, or groans when taken out of the water.” (W. J. Gordon—*Our Country's Fishes*.) In shape, the John Dory resembles a gigantic, rotund lemon, with large spines projecting from the extensive dorsal fin and several spiny rays supporting the front of the ventral fin. In profile, the line of the head with that of the operculum forms a slightly distorted rhomboid, with the large, protruding eye at its highest angle. Pectoral and pelvic fins are small, and the pelvics are directly under the pectorals. A large black spot edged with yellow, almost in the middle of each side, suggests a grotesque staring eye and gives the final touch to the humorous hobgoblin effect. The John Dory feeds on smelts, sprats and other young, medium-sized fish.

The Sting Ray.—Length, generally up to 33 in. The rays or skates belong to the cartilaginous class of fish, and are related to the sharks and dogfish. They differ from them, however, in being ground-feeders, grubbing in mud for their food. In connection with this habit, the body is flattened as if a flat-iron had been pressed down on the back, that is, the flattening is from back to front and not, as in soles, from side to side. In the flattening process the gill-slits—uncovered as in all cartilaginous fishes—have taken up a position on the under surface. In nearly all this group the first gill-slit and gill-pouch have been modified to form narrow tubes opening into the pharynx, while the gill has been reduced or lost.

In the rays this tube, called a spiracle, is on the upper (back) surface, and it serves as the inlet for the necessary current of water for respiration. Since the mouth is usually more or less buried in the mud, some other means of entrance for water is necessary.

The sting ray belongs to a different genus from the common skate ; its body is much more elongated and its tail longer, though it has the typical, almost diamond-shaped expanse, pointed snout and pointed side flaps. As in all members of the group, the mouth is on the underside, beneath the snout. The essential distinguishing feature, however, is a long, sharp spine, toothed like a saw, protruding upwards and backwards. At the base of this spine lies a poison gland. With a lashing movement of its powerful tail, the sting ray can inflict a serious wound by means of this stinging apparatus.

The Plaice.—Length, up to 33 in. The plaice has similar habits to those of the sole, the modifications of the body follow the same lines, and the plaice, like the sole, lies on its left side and has both eyes on the right. The underside (left) is white, the upper side (right) a dingy brown with numerous distinct reddish-orange spots. The plaice is oval in shape, but wider than the sole in the middle, and more pointed at both ends. It lives on sandy, muddy bottoms and feeds chiefly on molluscs, preferring those with two valves. A curious point is that the teeth on the left side are larger than those on the right. Possibly those on the left side get the first grip of the victim.

The Whiting.—Length, about 9 in. The whiting is a popular food fish. It is of a yellowish-silver colour, with very small scales. The head is pointed and the body slopes evenly in two straight lines from just behind the paired fins to the tail. The pelvic fins are some distance in front of the pectorals. The whiting belongs to the same Family as the cod and haddock and greatly resembles them in shape. It has three dorsal fins and two ventral or anal ones, the front one being very long. Whiting spend the winter in deep water, but, in summer, shoals appear off the coast amongst rocks and sandy bays, following the crustaceans and small fish on which they feed.

The Dogfish.—Length, 20–28 in. The dogfish, one of the cartilaginous fishes, is a small kind of shark, and is hated by fishermen for the havoc it plays amongst the shoals of mackerel and other food fish. It gets its name from the under-shot jaw which makes the muzzle look not unlike that of a dog, for as in all fishes of this class, the snout protrudes beyond the mouth. It is a powerful and swift swimmer. Its slim body tapers to the long tail, which is surrounded by a continuous caudal fin with the upper lobe much more prominent than the lower—a sort of

knife-edge, no doubt of importance in making the strong tail-strokes by which the fish is propelled.

The skin is covered by peculiar scales, consisting of square plates embedded in the skin, from which arise backward-directed, curved spines. The effect is that the skin looks and feels like velvet—unless it is stroked backwards, from tail to head, when all the little points can be felt. On the edge of the mouth these scales are rather larger, and inside the rim of the jaw identically similar structures form rows of primitive teeth, which can be replaced from the edge of the jaw as they wear down. There are four pairs of exposed gill-slits, and a pair of spiracles just behind the eye. The back and fins are dark ash-grey, spotted with brown, and the underparts are, as usual, lighter. The light colour of the underside of fish, and other animals, helps to counteract the shadow cast, and so reduces visibility.

In all the cartilaginous fish, eggs are fertilised by direct impregnation of the female, and not by spawning. The male is provided with claspers in the pelvic region. The embryo develops inside a horny, rectangular egg-capsule. In the case of the dogfish, this capsule is long and narrow, and drawn out at the corners into slender twisted filaments which fix themselves to some support—weed or rock.

The illustration on the Plate shows the Lesser-Spotted Dogfish.

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